

**Department of Defense  
Report to Congress on the  
High-Performance Manufacturing Technology  
Research and Development Pilot Program  
for Fiscal Year 2006**



**Under Secretary of Defense  
Acquisition Technology and Logistics  
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**FY06 High-Performance Defense Manufacturing Technology**  
**Research and Development**  
**Report to Congress**

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# **FY06 High-Performance Defense Manufacturing Technology Research and Development**

## **Report to Congress**

### **EXECUTIVE SUMMARY**

The vision of the Department of Defense (DoD) Manufacturing Technology (ManTech) Program is to realize a responsive, world-class manufacturing capability to affordably meet the Warfighter needs through the defense system life-cycle. ManTech is a proven contributor to greater affordability throughout the developmental cycle and into weapon operations and support phases. Building on this history, the defense-wide ManTech Program aims to provide the crucial link among technology development, procurement, and sustainment phases by maturing and applying manufacturing technologies that lower production risk and maximize life-cycle performance and affordability.

This report is in response to Public Law 109-163 (January 6, 2006), Subtitle D, High-Performance Defense Manufacturing Technology Research and Development (R&D), Sections 241 through 245 to help support the defense manufacturing base. DoD ManTech is unique in its potential reach. The Program invests in manufacturing research and development projects that develop capabilities to solve production challenges in weapons system development and sustainment. The Program positively impacts the defense manufacturing base by its close coordination with a wide range of stakeholders – industry, technology developers, military systems developers, logistics personnel, the sustainment community, and the acquisition work force.

This report includes three main sections, as summarized below – FY06 R&D actions taken by the Services and Agencies, implementation of actions within the defense manufacturing base, and recommendations for additional future actions.

### ***FY06 ACTIONS***

Advanced manufacturing processes and technologies were identified using the requirements processes of the Army, Navy, Air Force, Defense Logistics Agency (DLA), and Missile Defense Agency (MDA). R&D was executed by these Services and Agencies in the areas of electronics, metals, composites, sustainment/readiness, and extended production enterprises. Manufacturing R&D technologies highlights (described in the Appendix) include focal plane arrays, Warfighter tools (for welding, drilling, and radiography), composites for helicopters, C-17, and missiles, sustainment of gas turbine engines and forged part dies, extended production enterprises that use information technology – modeling and simulation of design methods and tools for continuous process improvement (e.g., Six-Sigma and Lean).

In order to identify manufacturing processes and technologies for transition to the defense manufacturing base, the DoD ManTech Program interacted with the participants from Government and industry in consultation with the Office of the Secretary of Defense (OSD) Director Defense Research and Engineering (DDR&E), the Joint Defense Manufacturing Technology Panel (JDMTP), and the Small Business Innovation Research Program office (SBIR). The DoD ManTech Director, Office of the Deputy Under Secretary of Defense (Advanced Systems and Concepts),

Office of Technology Transition (ODUSD (AS&C/OTT)) provides oversight and guidance to the DoD ManTech Program activities and strategic planning in concert with other DDR&E initiatives. In FY06, the DoD ManTech Program, in consultation with the JDMTP, addressed Government/industry partnerships, Lean battery development, manufacturing readiness, DoD ManTech strategic planning, and other ways to disseminate pertinent defense manufacturing technologies.

Quality prototyping efforts are important to the transition of advanced manufacturing processes and technologies to the defense manufacturing base. Prototypes and testbeds were developed to validate the advanced manufacturing processes and technologies of the DoD ManTech Program. The primary means to develop these prototypes and testbeds is found within the Manufacturing Centers of Excellence and the Prototype Integration Facilities. Other transition tools used by the Services are Technology Transition Plans, Technology Transition Agreements, and Manufacturing Readiness Levels used in product development.

The JDMTP coordinated with industry to devise methods to disseminate enhancements through the Manufacturing Extension Partnership (MEP) Program and to identify contractor incentives to incorporate and utilize advanced manufacturing processes and technologies. In addition, Government/industry partnerships were established to successfully transition enhanced manufacturing technologies to the defense manufacturing base in the areas of batteries, flexible displays, and composites. Finally, other resources that provide a mechanism to share information on best practices and advanced manufacturing processes and technologies include the Navy Best Manufacturing Practices Center of Excellence (BMPCOE), the Air Force Technical Information Center (TIC), and Government/industry partnerships in the areas of combat meals, forging, and advanced casting.

### ***IMPLEMENTATION OF ACTIONS***

DoD ManTech effectively enabled the implementation of high-performance defense manufacturing technology in the defense manufacturing base in the three key areas of Lean development, manufacturing readiness, and roadmapping. The Lean Battery Initiative (LBI) – a JDMTP initiative to improve battery manufacturing – enabled surge capabilities to more quickly deliver critical batteries to the Warfighter. Manufacturing Readiness Levels (MRLs) were developed by a joint DoD Government/industry team coordinated by the JDMTP that offer a tool to enhance visibility into technological maturity and production readiness – thus improving the knowledge on which acquisition program decisions are based. Roadmapping activities were conducted by the joint ManTech (e.g., Government/industry) community under the auspices of JDMTP in the areas of power sources and radio frequency (RF) modules. Plans were made to address other critical manufacturing technology areas in 2007 that include orthotics and prosthetics.

## ***RECOMMENDATIONS FOR FUTURE ACTIONS***

The Under Secretary of Defense (Acquisition Technology and Logistics) (USD (AT&L)) has indicated that advanced manufacturing processes and technologies can be enhanced in the defense manufacturing base through continued and focused efforts of the DoD ManTech Program. Four areas require attention and continued focus. These areas include the following: roadmapping, partnerships with industry, Defense Acquisition University (DAU) development of training resources, and hosting of workshops and conferences with Government and industry to provide insight for DoD ManTech strategic planning and to identify and prioritize advanced manufacturing processes and technologies. To be most effective, the DoD ManTech Program will require continued high-level attention of the USD (AT&L) and the participating Services and Agencies, guided by a strategic plan that provides a coherent investment strategy to identify, prioritize and implement critical manufacturing technologies in order to maintain a healthy defense manufacturing base and to provide needed products for the Warfighter.

# **FY06 High-Performance Defense Manufacturing Technology Research and Development (R&D)**

*Report to Congress*

## **1 INTRODUCTION**

### **1.1 OVERVIEW**

The Department of Defense (DoD) Manufacturing Technology (ManTech) Program provides the crucial link between technology invention and industrial application. The Program matures and validates emerging manufacturing technologies to support low-risk implementation in industry and DoD facilities (e.g., depots and shipyards). The Program addresses production issues starting in Technology Development through transition to System Development and Demonstration and finally to production and sustainment. By identifying production issues early and providing timely solutions, the DoD ManTech Program reduces risk and positively impacts system affordability by providing solutions to manufacturing problems before they occur. Program results typically enable a critical Warfighter capability, reduce total ownership costs and cycle-time, and improve the productivity and responsiveness of the defense manufacturing industry.

### **1.2 SCOPE OF MANTECH**

The primary customers of the DoD ManTech Program are the acquisition and logistics program managers responsible for transitioning acquisition programs from development into production and for the repair, maintenance, and overhaul of fielded systems. The Program focuses on manufacturing-related needs that are pervasive across military systems and industry sectors. Investments that would benefit a single military system are the responsibility of system program managers and are not candidates for DoD ManTech funding.

The DoD ManTech Program draws on technology created throughout the science and technology base and works with the defense manufacturing industry, technology demonstration efforts, military system development, sustainment and logistics activities, and acquisition reform efforts including those focused on defense use of commercial technology. The Program is conducted with a wide range of organizations, including prime contractors, subcontractors, suppliers, hardware and software vendors, industrial consortia, manufacturing centers of excellence, colleges and universities, and research institutes as well as collaboration with the Services, Defense Logistics Agency (DLA), Missile Defense Agency (MDA), the Department of Commerce (DoC), the Department of Energy (DoE), the National Science Foundation (NSF), and the Department of Homeland Security (DHS).

### **1.3 PURPOSE OF REPORT**

This report is provided in response to Public Law 109-163 (January 6, 2006), Subtitle D, High-Performance Defense Manufacturing Technology Research and Development, Sections 241 through 245 to conduct a pilot program to identify and transition advanced manufacturing processes and technologies. This report includes three elements:

1. A comprehensive description of the actions undertaken during FY06 by USD (AT&L), DoD ManTech, the ManTech programs of the Services and DLA, and the MDA Manufacturing and Producibility Program;

2. An assessment of the effectiveness of actions to enhance research and development on manufacturing technologies and processes, and the implementation of such within the defense manufacturing base; and
3. USD (AT&L) recommendations for additional actions to be undertaken in order to increase the effectiveness of the FY06 actions to enhance manufacturing activities within the defense manufacturing base.

## **2 HIGH-PERFORMANCE DEFENSE MANUFACTURING TECHNOLOGY ACTIONS IN FY06**

One of the keys to an affordable and timely insertion of technology into a weapon system is to mature the manufacturing processes for producing that technology. The DoD ManTech Program assists in transition of technology by developing new and improved manufacturing processes that reduce cost and lower risk of defense systems. Program results typically enable a critical Warfighter capability, reduce total ownership costs, cycle time, and improve the productivity and responsiveness of the defense manufacturing industry.

This section provides a comprehensive description of the actions undertaken to conduct a pilot program to identify and transition advanced manufacturing processes and technologies to achieve significant productivity and efficiency gains in the defense manufacturing base.

### **2.1 PILOT PROGRAM FOR IDENTIFICATION AND TRANSITION OF ADVANCED MANUFACTURING PROCESSES AND TECHNOLOGIES (SECTION 241)**

The USD (AT&L) conducts the DoD ManTech Program under the authority of United States Code (U.S.C.), Title 10 (Armed Forces), Section 2521, that requires a defense manufacturing technology program to develop advanced manufacturing processes and technologies that provide product performance, operational, and affordability improvements for the Warfighter. By law, the DoD ManTech Program is to be conducted with a focus on the pervasive needs across military sectors as well as the defense manufacturing base (Reference: Section 2521 (b), Purpose of Program).

The DoD ManTech Program is managed by the ODUSD (AS&C) which has oversight of the ManTech programs that are executed by the Army, Navy, Air Force, and DLA. The DoD ManTech Director is Ms. Adele Ratcliff, ODUSD (AS&C), Office of Technology Transition (OTT) who provides oversight and guidance to the Services and DLA. In FY06, all of these components, as well as MDA, collaborated on a regular basis through the Joint Defense Manufacturing Technology Panel (JDMTP). Some highlights of FY06 advanced manufacturing processes and technologies projects are presented in the Appendix.

#### **2.1.1 Pilot Program Approach**

The DoD ManTech Program uses collaborative and innovative techniques to identify, prioritize, and transition high-performance defense manufacturing processes and technologies R&D. The DoD ManTech investment strategy is defined by considering the following:

- Focus on defense-essential needs and pervasive needs of industry;
- Leverage commercial practices and processes;



- Address reduced cost-of-ownership and system readiness enablers (e.g., enhancing the mean time-between-failures and life-cycle affordability);
- Explore joint interest, funding, and management with other Government entities and industry;
- Integrate "Lean" concepts in selected acquisition and sustainment projects;
- Pursue affordable sustainment initiatives addressing enterprise business practices to lower the total ownership cost of weapon systems;
- Seek approaches to impact supplier development and the defense manufacturing industry.

## **2.1.2 Consideration of Defense Priorities in Pilot Program**

The DoD ManTech investment strategy builds on the requirements processes of the Manufacturing programs of the Services and DLA, and the Manufacturing and Producibility (MP) Program of MDA that focus on consideration of defense priorities. Though the requirements processes are unique to each Service / Agency, a common theme in defining ManTech investment strategies is to identify, prioritize, and transition advanced manufacturing processes and technologies to meet Warfighter needs.

### **2.1.2.1 Requirements Process**

The DoD ManTech Program uses a three-fold process to develop its investment strategy: (1) a process study is conducted to identify requirements; (2) proposals and projects are identified, prioritized, and developed considering the defense manufacturing base capabilities and the user community needs; (3) the investment strategy is reviewed and approved by senior decision-makers.

First, the DoD pilot program considers Warfighter needs by reference to various types of requirements data that may be derived from one or more of the following resources:

- Specific needs documents that identify capability gaps – for example, the U.S. Army Training and Doctrine Command (TRADOC) Pamphlet 525-66, Force Operating Capabilities
- Roadmapping – for example, Navy ManTech and the Navy Manufacturing Centers-of-Excellence roadmaps to identify high payoff shipbuilding investments
- Program Executive Office (PEO) / Technology Executive Office (TEO) conferences – for example, Air Force PEO/TEO conferences to identify transition opportunities for future weapon systems
- ManTech staff site visits to identify manufacturing technology requirements for weapon systems – for example, Air Force ManTech visits to AF product centers (i.e., Aeronautical Systems, Electronics Systems, Air Armament, and Space and Missile Systems Centers) and air logistics centers (i.e., Warner Robins, Oklahoma City, and Ogden Air Logistics Centers) to identify requirements
- Warfighter Needs Reviews – for example, MDA Senior Advisory Group annual meetings to develop Prioritized Ballistic Missile Defense System Needs List
- Industrial Base Assessments – for example, Air Force studies to identify current and future defense manufacturing base needs

- Service / Agency Headquarters Office guidance on developing investment strategies to meet Warfighter needs

Secondly, the DoD ManTech Program works with a variety of stakeholders – the defense manufacturing base, acquisition defense weapons system program managers (PMs), RDT&E components, Systems Commands, depots, air logistics centers, AF product centers, shipyards, and/or Services and Agencies – to develop a manufacturing technology investment strategy that focuses on providing timely and affordable capability for the Warfighter. It is important to involve the defense manufacturing industry and the user community in the requirements process and to obtain user endorsement before final submission of any investment strategy to senior decision-makers. For example, the Army obtains user community requirements from the U.S. Army TRADOC, the Navy develops planned projects in conjunction with industry and the acquisition PM user, the Air Force develops its strategy by working closely with the product and logistics centers, DLA works with the depots and supply centers, and MDA key investment area subject matter experts work directly with Element Project Offices (e.g., the system development managers).

Finally, the DoD ManTech Program plan and proposals are submitted to senior decision-makers for review and approval of the most promising transformational manufacturing processes and technologies.

#### **2.1.2.2 Consideration of the JWSTP and Other OSD Planning Documents**

The DoD ManTech requirements process maps back to DoD priorities outlined in several OSD planning documents including the Quadrennial Defense Review (QDR), Defense Planning Guidance (DPG) and the Joint Warfighting Science and Technology Plan (JWSTP). In FY06 the DoD ManTech Program addressed issues that were major drivers in the DoD QDR. Acquisition over-runs were addressed in the Army-sponsored Uncooled Focal Plane Array Producibility project, and the issue of sustainment of legacy systems was addressed in the Air Force Engine Rotor Life Extension (ERLE) project. Both ManTech projects were recognized and honored for their outstanding FY06 technical accomplishments as recipients of the 2006 Defense Manufacturing Conference (DMC) Defense Manufacturing Technology Achievement Awards.

The JWSTP is published annually by the DDR&E Plans and Programs office. Since it is intended to provide defense guidance for the planners, programmers, and performers of defense S&T, it focuses on S&T needed to support future joint Warfighting requirements. It identifies future operational concepts and addresses a variety of new threats present in the national security environment. The JWSTP presents joint Warfighting objectives and identifies some of the most critical capabilities needed for maintaining the Warfighting advantage of U.S. forces. The DoD ManTech Program uses the JWSTP to assist in identifying advanced manufacturing processes and technologies that support U.S. technological superiority.

#### **2.1.3 Consultation with DDR&E, JDMTP, and SBIR to Develop Pilot Program**

In order to identify manufacturing processes and technologies for transition to the defense manufacturing base, the DoD ManTech Program is conducted in consultation with a wide range of organizations including DDR&E, the JDMTP, the Services, DLA, MDA, DoE, NSF, DHS, and DoC, industry, the defense manufacturing base, and the Director of the Small Business Innovation Research (SBIR) Program.

##### **2.1.3.1 Consultation with DDR&E**

The DoD ManTech Director works closely with several offices under the DDR&E. As an example, the Director works with the ODDR&E Plans and Programs directorate charged with aligning research and technology opportunities with funding mechanisms

to enable the DoD to provide the best Warfighting capabilities. The directorate is responsible for the strategic planning process for the Department's S&T program and publishes several important documents that outline the Department's S&T priorities including the JWSTP mentioned above. Other documents published by Plans and Programs include the Defense Technology Area Plan, Basic Research Plan, and S&T In-house Activities Report that are good resources for DoD ManTech Program investment planning.

In FY06, the DoD ManTech Director frequently participated as a proposal evaluator with the members of ODDR&E Comparative Testing Office to review proposals for the Defense Acquisition Challenge (DAC) and Foreign Comparative Testing (FCT) programs. The DAC Program solicits 'challenges' to existing technologies to provide companies, individuals, and defense acquisition programs an on-ramp for increased introduction of innovative and cost-saving technologies. The FCT Program facilitates the test and evaluation of foreign non-developmental equipment and technology to satisfy U.S. military requirements. DoD ManTech Office participation in these technical reviews provides cross-fertilization of technology innovations and offers yet another resource from which to identify opportunities for advanced manufacturing processes and technologies to meet Warfighter needs.

#### **2.1.3.1.1 DDR&E Advanced Materials, Manufacturing, and Testing Information Analysis Center (AMMTIAC)**

The DDR&E sponsors the AMMTIAC – a manufacturing community resource of scientific and technical information related to advanced materials, manufacturing and testing (AMMT). The AMMTIAC is responsible for acquiring, archiving, analyzing, synthesizing, and disseminating AMMT scientific and technical information.

In FY06, AMMTIAC maintained DoD's entire knowledge base of AMMT technology in an extensive library offering nearly 300,000 technical reports, research papers, and reference books. A wide-ranging data-acquisition program continually adds reports to the library that are developed by the Services, thus ensuring the collection's relevance and currency to both newly emerging DoD requirements and fielded assets. AMMTIAC assists DoD's AMMT research communities by providing access to critical enabling technologies in various ways. The AMMTIAC Quarterly, for example, a highly regarded technical publication, reaches over 22,000 people in the AMMT community and regularly highlights new manufacturing technologies sponsored by the Services.

AMMTIAC also provides direct online access to a variety of databases and information systems to directly support the research, development, acquisition, and sustainment communities including the Composites Affordability Initiative's (CAI) Process Maturation Database. This database enables accelerated technology transition by providing a single repository for the performance capabilities provided by maturing composite materials processes. AMMTIAC's services include training. For example, the Lean Enterprise Re-Architecting Certification course was developed and offered to both Government and industry in FY06. This course is designed with DoD transformation in mind as it covers organizational design, Lean manufacturing, supply chain analysis and design planning.

#### **2.1.3.2 Consultation with the JDMTP**

The DoD ManTech Program coordinates activities through the JDMTP which operates under a charter signed by the DDR&E and the S&T Executives of the Army, Navy, Air Force, and DLA. The JDMTP is responsible for establishing a process to effectively transition technology by identifying and prioritizing requirements for advanced manufacturing technologies and processes, conducting joint program planning, and developing joint strategies for the ManTech programs of the Army, Navy, Air Force, DLA, and the MDA Manufacturing and Producibility Program.

The principal members of the JDMTP include the ManTech Directors of each of the Services and DLA, and the Manufacturing and Producibility Director of MDA. The DoD ManTech Director, ODUSD (AS&C/OTT), serves as an ex-officio member of the JDMTP to promote coordination and cooperation with regard to ManTech and manufacturing technology-related programs. Other ex-officio members include senior technical managers from the Offices of the Secretary of the Army and of the Air Force, the DoC National Institute for Standards and Technology (NIST), and the DoE Sandia National Labs. The JDMTP coordinates with the defense manufacturing base through its industry liaison, the National Center for Advanced Technologies (NCAT). In doing so, the JDMTP maintains a close working relationship with numerous industry associations including the National Defense Industrial Association (NDIA), the Government Electronics Industry Association (GEIA), and the Aerospace Industries Association (AIA). In addition to the main panel, JDMTP has three first-tier sub-panels – Metals, Composites, and Electronics – and two second-tier Technology Working Groups on Power and Energy and RF Modules that review and coordinate advanced manufacturing process and technology efforts in the indicated technology areas.

#### **2.1.3.2.1 The JDMTP Coordination with Industry**

NCAT is a not-for-profit organization with the goal of facilitating communication between industry, academia and the Government community in order to promote affordability and to reduce the cycle-time for technology transition. DoD ManTech leverages NCAT's substantial industry and academic partnerships to address technological and management issues such as Joint Technology Transition Initiatives, Manufacturing Technology Roadmaps, Industrial Partnerships, Evolutionary Acquisition Strategies, Manufacturing Readiness Levels (MRLs), and Affordability.

DoD ManTech relies on NCAT to identify and draw on the resources of key stakeholder representatives from industry, academia and government and to facilitate industry participation in the JDMTP through the Multi-Association Industry Affordability Task Force. At the direction of the JDMTP, NCAT forms specific manufacturing study teams and nominates appropriate industry representatives to participate in the three standing technical JDMTP sub-panels. DoD and industry work together to address common issues facing both industry and DoD communities.

The current membership of the Multi-Association Industry Affordability Task Force includes the members from the Industry Associations and Professional Societies listed below:

- Aerospace Industries Association (AIA)
- Electronic Electronics and Information Association (GEIA)
- National Defense Industrial Association (NDIA)
- Society of Manufacturing Engineers (SME)
- National Association of Manufacturers (NAM)
- Armed Forces Communications and Electronics Association (AFCEA)
- Association for Manufacturing Technology (AMT)
- American Electronics Association (AEA)
- National Council for Advanced Manufacturing (NACFAM)
- National Center for Manufacturing Sciences (NCMS)

In FY06, industry partners supported the DoD ManTech Program and the JDMTP in the following efforts:

- Assembled and coordinated a broad range of private sector viewpoints relative to manufacturing technology, technology transition, and related activities devoted to reducing cycle- and span- times for evolutionary acquisition and to improving the manufacturing structure and organization of evolving industry sectors;
- Participated in the JDMTP's Portfolio Review process by providing industry experts to participate in the annual sub-panel Portfolio review process (see Section 2.1.3.2.4);
- Participated in an industry/government workshop to review and improve detailed MRL definitions;
- Formed an Industry advisory group to construct definitions of MRLs, and provide industry comments into any policy regarding the adoption of MRLs for increased technology transition success (see Section 2.1.3.2.3 for more information);
- Convened teams of private sector, university, and association representatives to address relevant defense policy, strategic planning, or transition;
- Supported the DMC recruiting industry panel members and other speakers, and for preparing issue position papers and draft panel questions.

In FY06, the JDMTP also collaborated with multiple industry groups to respond to P.L. 109-163 for High-Performance Defense Manufacturing Technology Research and Development. Meetings were held with NDIA (Manufacturing Division), NCMS, and the Next Generation Manufacturing Technology Initiative (NGMTI) to conduct exploratory discussions on potential advanced manufacturing process and technology opportunities for partnership. Topics of discussion included industry's ability to identify, prioritize, and collaborate on critical technologies in a pre-competitive environment, speaking with a unified voice on issues, and identifying contractor incentives. Roadmapping activities were also conducted by the JDMTP and industry in the areas of RF modules and power sources (these are discussed in Section 2.3 of this report).

The JDMTP and industry groups support increased manufacturing technology investments in technology initiatives and specific projects that focus on cross-cutting military and industry manufacturing needs for critical enabling technologies in the areas of electronics, metals, composites, sustainment and readiness, and extended production enterprises using information technology.

#### **2.1.3.2.2 The JDMTP and Lean Development**

Lean principles and practices were first introduced to the DoD and the defense manufacturing base through an Air Force ManTech initiative 15 years ago when Lean practices were just beginning to be embraced by the U.S. automotive industry. Those early steps led to the founding of the Lean Aircraft Initiative and subsequently to a very broad embrace of Lean principles and practices in aerospace manufacturing and repair facilities, resulting in exceptional payoffs in cost and cycle-time. The current DoD-wide emphasis on Lean and Six Sigma can trace its roots back to the Lean Aircraft

Initiative. The Lean Aircraft Initiative has since broadened to become the Lean Aerospace Initiative, a collaborative effort among the Services, the aerospace industry and academia aimed at doing research and expanding knowledge in the area of Lean practices.

#### **2.1.3.2.2.1 Lean Battery Initiative (LBI)**

The LBI was a joint investment – managed by the JDMTP and funded by OSD, MDA, Army, DLA Warstoppers, and industry – to ensure the battery industrial base will never again be a limiting factor in supporting the Warfighter. The LBI was a two-year program that was completed in October 2006. The LBI solved problems related to the two most critical batteries used by our Warfighters – military batteries BA-5590 and BA-5390. The Initiative provided industrial base-wide process improvements that cut across three battery producers, improving production 300%. With improved operational readiness, the battery manufacturing base is now more capable of responding to sharp fluctuations in battery demand.

Primary lithium batteries are the power source for over 200 systems used by the Warfighter of today. During Operation Iraqi Freedom the supply of military unique lithium batteries almost reached zero days of in-theater supply, with this commodity being the only logistics issue briefed to the President. The most significant problem was the inability of the production base to keep pace with demands. Chief contributors were limited production capacity, long lead-times for supply chain and production equipment and relatively high levels of scrap.

The LBI team consisted of Government personnel, Lean enterprise specialists and the lithium battery production base. Value stream and capacity analyses of the BA-5590/BA-5390 battery supply chain were conducted and supply chain performance improvements were identified. This led to implementation of a combination of Government and company-funded corrective actions – including reorganization or start-up of factory floor production and test processes, pre-positioning of long lead-time components and introduction of automation and other technology improvements to increase product consistency and production flexibility.

The LBI project has freed up capacity for the other twelve battery configurations in this family and has improved the quality and reduced both the cycle-time and the testing lead-times of all the batteries. As a follow-on effort, MDA is working with the Reserve Battery Industrial base, through the NDIA, in an effort to apply similar Lean principles to the production of reserve batteries for military systems.

#### **2.1.3.2.3 The JDMTP and Industry Development of MRLs**

Understanding and minimizing production risks are essential elements for enabling the implementation of innovative processes and technologies. In FY06, a joint DoD and industry group (under the direction of the JDMTP) developed a set of MRL definitions to provide a common tool for evaluating the manufacturing maturity of a technology or weapon system program. The MRL tool is used to assess the manufacturing readiness of technologies and programs in an effort to reduce cost, performance, and schedule risk. MRLs complement existing Technology Readiness Levels (TRLs) and provide common language to assess the maturity and risk of a technology's underlying manufacturing processes. Joint DoD/industry MRL workshops were held in FY06 to develop MRL definitions and to get feedback from government and industry participants on the latest version of both definitions and the associated manufacturing readiness exit criteria matrix

Examples of the use of MRLs by Service S&T programs to improve Manufacturing Readiness for technology transition include the following:

- The Air Force used MRL criteria to perform assessments on two ACAT 1 programs and ten Advanced Technology Demonstrations.
- The Air Force has adopted a formal Manufacturing Readiness Assessment process that identifies the highest risk areas for production.
- The Army used MRLs on selected 6.3 programs that have manufacturing issues tied to Army Manufacturing Technology Objectives and on all key technologies for the Future Combat System (FCS).
- The Army uses MRLs on selected SBIR projects and some acquisition programs piloted the use of MRLs to assess manufacturing risk.
- The Army is increasingly using MRL definitions to define the exit criteria in their contracts with industry to “incentivize” contractors to reduce manufacturing risk.

In FY06, JDMTP managed development of a prototype web-based tool – the MRL Assist – and created other tools that include an MRL Guidebook and Deskbook, and an annex to the Technology Readiness Assessment Guidebook and Deskbook. The DoD ManTech community also worked with the Defense Acquisition University (DAU) to develop an online resource for MRLs that can be found at <https://acc.dau.mil/pqm>. The Web site includes an interactive manufacturing readiness folder, listing of MRLs, questions, exit criteria, tutorial, and acquisition program examples. The Web site typically logs thousands of hits per month.

#### **2.1.3.2.4 The JDMTP Sub-panel Annual Portfolio Review**

By charter, the JDMTP is to conduct comprehensive reviews and assessments of its members’ investment strategies and projects in order to identify joint opportunities for development, implementation and funding with the private sector and other Services and Agencies.

In FY06, the ManTech projects of the Services, DLA, and MDA were coordinated with JDMTP through its first-tier sub-panels – Electronics, Metals, and Composites. The sub-panels are required to perform annual reviews of projects within their portfolios and then present the results to the JDMTP Principal members. The purpose and type of review performed varies significantly depending on what part of the project life-cycle a specific project is in. JDMTP has defined four types of projects:

Type A -- Projects that are planned and not yet started or have started very recently;

Type B -- Projects that are currently underway and will not complete before the end of the current fiscal year;

Type C -- Projects that are underway, but will complete within the current fiscal year;

Type D – Project completed within the past 5 years.

Sub-panels form review teams that include representatives from each of the Service / Agency components (normally sub-panel members), and such outside reviewers from industry or other organizations as the Sub-panel Chair may deem appropriate. Reviews are typically conducted on-site at the facility where the projects are managed, but are sometimes conducted via video conference to reduce travel requirements. Some of the criteria used in conducting the Portfolio Reviews include: jointness, customer needs and benefits, measures of effectiveness (i.e., metrics), transition potential, funding and milestones, and leveraging or sharing of resources.

#### **2.1.3.2.5 Defense Manufacturing Conference (DMC)**

The DMC is held annually during the latter part of November or early December to provide a Government / industry forum for addressing the challenges of manufacturing technology in Government and across the defense manufacturing base. The conference is coordinated on a rotating basis by the Army, Navy, Air Force, DLA, or MDA on behalf of the DUSD (AS&C) and the JDMTP. DMC brings together leaders from Government, industry, and academia to exchange perspectives and information about critical DoD manufacturing technologies and issues.

Average attendance in the past four years has exceeded 950. The attendance is typically split between Government and industry participants, with a small complement from academia. Participants range from Chief Executive Officer and Flag Officer/Senior Executive Service- level attendees to working-level engineers.

The agenda for the conference is structured to provide an overview of defense manufacturing technology and sustainment challenges, as well as detailed technical discussions relating to the various initiatives and technology thrusts currently being pursued. Critical issues include key technology development status, system/subsystem acquisition and sustainment affordability, diminishing supplier sources, assuring domestic technology transfer and the opportunity for greater use of commercial industrial processes and business practices for defense needs.

The conference general sessions feature keynote speakers from the DoD, the Services, defense-related associations and industry who add their experience, expertise, and insight to address the theme of the conference. The technical sessions focus on topics such as metals, electronics, and composites processing, Lean manufacturing, munitions, missile defense sponsored technologies, supply chain, Defense Production Act Title III, Small Business Innovation Research, and MRLs. Government and industry attendees also have the opportunity to interface with over one hundred and ninety exhibits that depict current, near-term and long-range DoD/industry manufacturing and sustainment initiatives.

DMC is used as the forum to present the annual Defense Manufacturing Technology Achievement Award that recognizes and honors individuals – both Government and private sector – who are most responsible for outstanding technical accomplishments and contributions in achieving the vision of the DoD ManTech Program. As mentioned previously, the ManTech projects recognized for their outstanding FY06 technical accomplishments as co-recipients of the Defense Manufacturing Technology Achievement Award at DMC '06, were the Uncooled Focal Plane Array Producibility project and the Engine Rotor Life Extension (ERLE) project.

Overall, DMC is the premier national forum for presenting and discussing initiatives aimed at enhancing defense manufacturing capabilities, counterpart industry initiatives, platform/system/subsystem affordability, and sustainment efficiency, as well as assuring domestic technology transfer.

#### **2.1.3.2.6 DoD ManTech Web Site**

The DoD ManTech Web Site (<https://www.dodmantech.com>) is provided as a public service by the ODUSD (AS&C)/OTT. The Web site is an online source of information on the DoD ManTech Program; its projects, activities, and funding; and other affiliated components.

The site provides both a Home Page for public access and a Desktop for which access is granted only to JDMTP members and selected users. The latter is used extensively by the JDMTP participants to provide ready access to on-going information about specific projects, initiatives and actions.



## DoD ManTech WebSite – Home Page (Public Access Portion)



### 2.1.3.3 Consultation with the Small Business Innovation Research (SBIR) Program

The Service and DLA ManTech programs and MDA MP Program are in continuing dialogue and coordination with the SBIR Program in order to develop and refine a common strategy toward transitioning SBIR technologies into products. The overall goal is to provide future innovative Warfighting capabilities by leveraging the technology innovations of small businesses and non-traditional suppliers.

In FY06, DoD ManTech specifically responded to Executive Order (E.O.) 13329, “*Encouraging Innovation in Manufacturing*”, signed into law on January 6, 2006 (PL 109-163, Section 252). The law calls for the SBIR program managers to identify and prioritize R&D topics that support manufacturing. E.O. 13329 encourages SBIR to support these innovations in manufacturing and to collaborate with the DoD ManTech community. On July 25, 2006, representatives from OTT (ODUSD-AT&L), OSD SBIR and the Small Business Technology Transfer (STTR) programs met to discuss potential program synergies vis-à-vis manufacturing and commercialization. The following highlights were reported on DoD ManTech community actions to address SBIR innovations.

The OSD SBIR/STTR Program conducted analyses of its SBIR proposal database to identify manufacturing-related proposal topics. 603 manufacturing projects (27% of the database) were found to predominantly fall within the materials and processes technology areas. The overall DoD ManTech approach is to use this SBIR database to identify manufacturing-related SBIR topics that the DoD ManTech Program may prioritize and fund through SBIR Phase III development and into defense manufacturing base implementation. The goal is to coordinate with SBIR and the individual SBIR contractors to develop a coordinated approach and plan to transition transformational manufacturing processes and technologies rather than to simply apply ManTech funds to existing SBIR proposals. Also, it is planned to hold sessions at future DMCs to discuss SBIR and DoD ManTech coordination.

The Army approach was to: (1) set up a working group between the Army SBIR and Army ManTech communities; (2) have Army Technology Objective - Manufacturing (ATO-M) managers review, evaluate, and endorse manufacturing-related topics; and (3) review Phase II efforts for potentially leveraging ManTech investments and projects.

To assist in this coordination, the Army developed definitions for five categories of manufacturing-related topics that are: (1) core manufacturing; (2) significant manufacturing-related innovation; (3) manufacturing aspects related to product or system; (4) potential to apply techniques of project to manufacturing; and (5) some indirect manufacturing applications.

The Army has focused many efforts on promoting manufacturing-related projects within the SBIR Program. The Army SBIR/STTR public Web site brings together the small business community, Army researchers, Army Programs of Record, prime contractors, and the ManTech community for possible collaboration on new and ongoing SBIR projects. The Army SBIR office PM tracks and reports SBIR and STTR success stories through the Army SBIR/STTR Commercialization Brochure which is an excellent opportunity for Army organizations and Small Businesses to share information about their SBIR and STTR projects and successes. The brochure is distributed at Army, Defense, and National conferences providing exposure to these exceptional SBIR and STTR projects.

For the Navy, the Navy ManTech Program Office and the Navy SBIR/STTR Division reports to the Director of Transition (Code 03T) at the Office of Naval Research. This naturally results in a close working relationship between these activities: project topics are coordinated, recommended actions are communicated, and, as appropriate, the entities interact on specific projects. Two examples of project coordination / project extension under ManTech include the Weld Quality Control and the Low Cost, Large Pultruded Composite Panels for Ship Structures efforts.

In the Weld Quality Control effort, the Navy ManTech Program is leveraging work done on a 2006 Phase II SBIR project to prototype a web-based software system that significantly reduces the costs associated with the development and review of Navy welding procedures and welder performance qualifications that satisfy U.S. Navy welding specifications. In the second effort, a 2006 Phase II SBIR project is being extended by PEO (Ships) to evaluate pultruded panels for the Peripheral Vertical Launch System on the DDG 1000. The Navy ManTech Composites Manufacturing Technology Center (CMTC) is considering additional ManTech funding to fully certify the pultrusion process as an alternative to the vacuum-assisted resin transfer molding process. Details on both of these projects can be found in Appendix A under the respective section headings of metals and composites.

A further example of the close cooperation between Navy ManTech and the SBIR Program is that Navy ManTech Program is currently working with Frontier Technology, Inc., a small business which has been developing a cost assessment tool under the SBIR Program, in an attempt to employ that tool for assessing the affordability impact of its cost reduction efforts for four ship classes (DDG 1000, CVN 21, Littoral Combat Ship, and the VIRGINIA Class Submarine).

The Air Force proposed an innovative approach to improve the responsiveness of SBIR work by identifying high payoff manufacturing SBIR opportunities and working closely with technology “end users” and system program offices to ensure their transition. The Air Force approach establishes a business case and technology transition plan jointly with the program office and technology end user as part of each manufacturing SBIR topic. This approach has been coordinated with weapon system program offices. The strategy is to identify high priority PEO manufacturing requirements in a wide range of advanced manufacturing topic areas. Initial efforts have focused on robotic technologies supporting manufacturing and on the application and maintenance of aerospace coatings. Topic areas are not limited to any particular segment of the aerospace business, but are developed based on customer requirements, insertion windows, and potential payoff. Focus is on maturing technologies that need additional investment to reduce manufacturing risk to an acceptable level and to efficiently transition technology to the manufacturing production floor.

DLA planned to start its SBIR Program in 2007. Initial awards were expected during the first quarter of FY08. The DLA seeks to provide responsive, best value supplies consistently to its customers. DLA continually investigates diverse technologies for manufacturing which would lead to the highest level of innovation in the discrete-parts support of fielded weapon systems (many of which were designed in the 1960's, 1970's and 1980's) with a future impact on both commercial technology and Government applications. As such, advanced technology demonstrations for affordability and advanced industrial practices to demonstrate the combination of improved discrete-parts manufacturing and improved business methods are of interest. All these areas of manufacturing technologies provide potential avenues toward achieving breakthrough advances. Proposed efforts funded under this topic may encompass any specific discrete-parts manufacturing technology at any level resulting in a unit cost reduction. DLA's philosophy in selecting SBIR awards is to prefer market-driven companies that can move the technology into the commercial high volume market. Therefore DLA SBIR Phase II selections will be strongly influenced on future market possibilities and commercialization potential demonstrated. The demonstration of commercialization potential is best evidenced by Phase II funding commitments, public or private, submitted as part of the Phase II proposal.

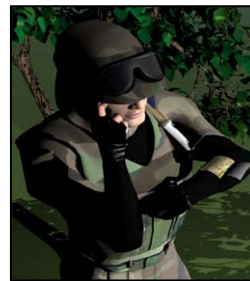
MDA provides approximately 18% funding of the entire MDA SBIR budget to fund manufacturing-related SBIRs. In FY06, proposals were actively sought that demonstrate new and innovative process technologies that reduce cost and manufacturing cycle-time, improve performance, and/or improve reliability. MDA also seeks the following in response to their manufacturing-related SBIR topics: Technology roadmaps for implementing promising manufacturing technology processes into current or future supply chain; and plans for near term insertion into ballistic missile defense element systems, subsystems, or components. Other actions conducted by the MDA in response to the E.O. 13329 included the following:

- Referenced and established a link to E.O. 13329 on the main page of the MDA SBIR/STTR website (<http://www.winmda.com>).
- MDA continues to work with its Prime Contractors to keep them informed of current manufacturing related SBIR investments.
- MDA is working with the newly formed NDIA Manufacturing Division to identify opportunities for small business involvement in the MDA SBIR Program.
- All SBIR/STTR Phase I and Phase II awardees were offered, free of charge, the services of the National Technology Transfer Center (NTTC). The services provide individualized business assistance through regional workshops funded by MDA. The NTTC leverages the expertise of technology and business experts to accelerate the maturation and commercialization of technology. The NTTC collects and maintains extensive data on MDA technology developments and their uses. The NTTC provides wide and highly positive exposure for technology developments, and benefits MDA and the country through a high traffic Web site and award winning publications.
- Conducted several planning meetings with representatives from the NIST Manufacturing Extension Partnership (MEP). Should MDA participate in the commercialization pilot program in FY07, NIST MEP may be funded to provide focused efforts to MDA Directorate for Producibility and Manufacturing SBIR awardees.

## 2.2 TRANSITION OF TRANSFORMATIONAL MANUFACTURING PROCESSES AND TECHNOLOGIES TO THE DEFENSE MANUFACTURING BASE (SECTION 242)

The DoD ManTech Program attempts to positively impact the defense manufacturing base in the transition of transformational manufacturing technologies and processes from the research stage to utilization by manufacturers in the defense manufacturing base through close interaction with industry. The Program helps transition transformational manufacturing processes and technologies to military system programs and across industry by its early intervention in technology development. A relatively small ManTech investment early on may allow the DoD to leverage the billions of dollars that commercial industry is spending on technologies to strive to excel in worldwide competition. Some examples of Warfighter products developed with the assistance of ManTech funding are:

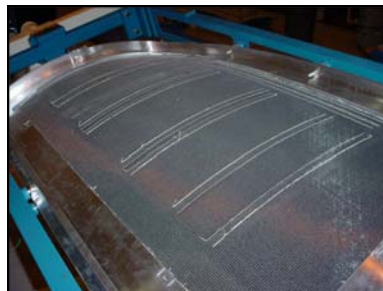
- New body-worn **flexible displays** to eliminate bulky, heavy, glass displays carried by the soldier



- New **battery** systems with greater energy density for Navy Seals



- New **stitched resin infusion manufacturing process** to prevent delaminating and structural damage to air crew doors of C-17 MX air vehicles



### **2.2.1 Pilot Program Prototypes and Testbeds**

The DoD ManTech Program develops prototypes and testbeds to validate its advanced manufacturing processes and technologies developed under the Program. A means to develop some of these prototypes and testbeds is within the Centers of Excellence (COEs) and the Prototype Integration Facilities (PIFs). Both of these entities have the combined Government, academic, and industrial expertise and access to expert consultants to help transition advanced manufacturing technology and processes to the Warfighter and to industry applications.

#### **2.2.1.1 Manufacturing Centers of Excellence**

The COEs provide a focal point for the development, test, and transition of new manufacturing processes and equipment in a cooperative environment with industry, academia, and DoD. Each center is focused on a specific technical area and manages ManTech projects in those areas (see Table 1 for a summary of the manufacturing centers funded by the Navy and the Army). Each center has a Web site and most COEs publish a newsletter that contains ManTech data of interest to DoD ManTech and the defense manufacturing base. The individual COE Web sites can be accessed through the links at [https://www.dodmantech.com/program/coe.asp?main\\_program](https://www.dodmantech.com/program/coe.asp?main_program).

The objectives of the COEs are to: (1) develop and demonstrate manufacturing technology solutions for identified defense manufacturing issues; (2) serve as corporate residences of expertise in their particular technological areas; (3) provide consulting services to defense industrial activities and industry; (4) facilitate the transfer of developed manufacturing technology; and (5) provide advice to the DoD ManTech Program directors concerning program formulation.

The COEs help promote technology transition and industry implementation of transformational manufacturing technologies and processes. For example, Navy COEs are involved in manufacturing technology development from inception to end product results. Through a combination of the expertise in the Navy COEs and the interaction between the Navy Program Offices and the acquisition program manager in the identification and selection of projects, ManTech results are evaluated through both peer review and the Government and industrial entities responsible for implementing the technology.

The following examples – the Navy Joining Center (NJC), the National Center for Defense Manufacturing and Machining (NCDMM), and the Electronics Manufacturing Productivity Facility (EMPF) provide insight into how the COEs work with industry to develop, test, prototype and implement advanced manufacturing processes and technologies.

##### **2.2.1.1.1 The Navy Joining Center and Teaching Factory**

The NJC, funded by the Navy ManTech Program and operated by Edison Welding Institute (EWI), provides a national resource for the development of materials joining expertise and the deployment of emerging manufacturing technologies to defense contractors, subcontractors, and other activities. Project thrusts include the joining of metallic, non-metallic, ceramic, and composite materials. The NJC has disseminated project results and other joining information through the NJC Teaching Factory, combining traditional technology transfer mechanisms with modern communication and information systems. The NJC rapidly deploys its resources and expertise to craft solutions to meet system performance needs and production requirements. This results in manufacturing innovations that make tangible improvements in the cost and performance of key weapons systems.

**TABLE 1. Army and Navy Manufacturing Centers of Excellence**

| <b>COE</b>   | <b>PARTICIPANTS</b>   | <b>GOAL</b>   | <b>LOCATION</b>          |
|--|---|---|--------------------------|
| Best Manufacturing Practices Center of Excellence (BMPCOE)       | Navy<br>Dept. of Commerce<br>University of Maryland<br>Industry | Disseminate information on exemplary manufacturing and business practices to U.S. manufacturers   | College Park, MD         |
| Center for Naval Shipbuilding Technology (CNST)                  | Navy<br>ATI<br>Industry   | Identify, develop and deploy in U.S. shipyards, advanced manufacturing technologies to reduce cost and time to build and repair Navy ships                    | Charleston, SC           |
| Composites Manufacturing Technology Center (CMTC)                | Navy<br>South Carolina Research Authority (SCRA)<br>Industry    | Disseminate composite material manufacturing technology to defense industry to reduce life-cycle cost and factory implementation time                         | Anderson, SC             |
| Electronics Manufacturing Productivity Facility (EMPF)           | Navy<br>American Competitiveness Institute (ACI)<br>Industry    | Identify and transfer innovative electronics manufacturing processes to domestic firms  | Philadelphia, PA         |
| Electro-Optics Manufacturing Technology Center (EOC)             | Navy<br>Penn State University<br>Industry                       | Work with industry and academia partners to address EO needs of military and transition manufacturing R&D   | Freeport, PA             |
| Energetics Manufacturing Technology Center (EMTC)                | Navy<br>Industry  | Ensure industrial base availability and affordability of quality energetics to meet Warfighter needs  | Indian Head, MD          |
| Flexible Display Center (FDC)                                    | Army<br>Arizona State University<br>Industry                    | Rapidly develop innovative new generation of displays that are flexible, lightweight, low power, and rugged to meet needs                                     | Arizona State University |
| Institute for Manufacturing and Sustainment Technologies (iMAST) | Navy<br>Penn State University<br>Industry                       | Transition manufacturing technology to industry in areas of mechanical drive transmissions, high energy processing, materials science and repair technologies | State College, PA        |
| National Center for Defense Manufacturing and Machining (NCDMM)  | Army<br>Industry  | Work with industrial base to address machining issues facing the DoD and defense manufacturing industry   | Latrobe, PA              |
| Navy Joining Center (NJC)  | Navy<br>Edison Welding Institute (EWI)<br>Industry              | Transition materials joining expertise in thrust areas of metals, non-metals, ceramics, and composite materials to industry                                   | Columbus, OH             |
| Navy Metalworking Center (NMC)                                   | Navy<br>Concurrent Technologies Corporation (CTC)<br>Industry   | Develop capabilities in advanced materials testing, process development/modeling, component design, concurrent engineering, systems technology                | Johnstown, PA            |



During FY06, the NJC Teaching Factory provided technology demonstrations, production prototyping and the dissemination of new material joining technologies to government and industry. By supporting the widespread transfer of manufacturing technologies to the Navy and domestic industry, the Teaching Factory encouraged wider technology adoption and an increase in the return on the Government's investment. Benefits to the Navy and industry include increased productivity, reduced manufacturing costs, increased product quality, and improved product performance. The Teaching Factory receives significant cost leveraging from the state of Ohio, and builds on existing technical resources and the outreach of NJC team members.

During FY06, teaching activities were performed on site at the NJC as well as at team member facilities, Navy facilities, and end-user sites. The Teaching Factory demonstrated technology developed at NJC, developed and conducted workshops and short courses, provided rapid access to new technology, and supported the commercialization of joining and inspection tools. Historical data developed through customer surveys of similar activities by EWI, indicate that Teaching Factory actions result in improved joining quality and reduced rework, improved productivity and reduced costs.

#### **2.2.1.1.2 The National Center for Defense Manufacturing and Machining (NCDMM)**

The NCDMM, funded through the Army's ManTech Program, focuses on training and the implementation of high performance manufacturing materials and processes in the defense industrial base. This ensures lower costs due to the use of state-of-the-market manufacturing and machining processes and mitigation of offshore manufacturing capabilities in materials, processes, tooling and machine computer control systems.

Testing and prototyping of manufacturing lines is particularly critical to the small U.S. "mom and pop" manufacturing facilities. NCDMM and its industry Alliance Partners helped these small manufacturing industries to model and simulate their lines and test their manufacturing processes before making large capital investments in equipment. In FY06, NCDMM worked with numerous DoD organizations and their industrial supply base to address manufacturing and machining needs. Through these interactions, NCDMM developed and delivered innovative solutions for the benefit of DoD, industry, and the U.S. Warfighter.

In FY06, NCDMM had 59 Alliance Partners from industry to support the activities of the center with state-of-the-art skills and capabilities to solve machining and manufacturing issues faced by DoD and contractors.

Another NCDMM program related to testing is Joint Ultimate Manufacturing Process Evolution and Development (JUMPED). JUMPED was conceived by the NCDMM in order to effectively transition technologies to the factory floor at lower costs, enhanced quality, and increased capacity. JUMPED accelerates the deployment of "ultimate" manufacturing and machining solutions at DoD stakeholder facilities. The JUMPED process is a collaborative initiative that leverages the use of the NCDMM Testing and Development Laboratory for the performance of complete turnkey projects. One example of a JUMPED project is for the development of best manufacturing processes for various components of the new Excaliber artillery round that were developed at the U.S. Army Research, Development and Engineering Command (RDECOM) Armament Research Development and Engineering Center (ARDEC), Picatinny Arsenal, NJ.

NCDMM is dedicated to training the next generation of manufacturing engineers in the latest machining and manufacturing processes. They deliver custom manufacturing technology training and awareness programs designed to keep key employees on the cutting edge of advanced technologies. A typical class is less than 50 students of machine operators, shop floor engineers, process planners, and manufacturing managers who can apply these techniques to their every day applications. Trainers were provided

by the NCDMM and its Alliance Partners engaged in developing new manufacturing and machining technologies.

#### **2.2.1.1.3 Electronics Manufacturing Productivity Facility (EMPF)**

The EMPF, funded by Navy ManTech and operated by the American Competitiveness Institute (ACI), identifies, develops, and transfers innovative electronics manufacturing processes to domestic firms in support of the manufacture of affordable military systems. The EMPF receives guidance from an ACI Industrial Advisory Board, which consists of representatives from major Defense manufacturers. The Board provides important feedback to ensure that the key electronics manufacturing issues are identified, documented, and represented on the research agenda of the Center.

A Demonstration Factory, supported by many electronics manufacturing equipment manufacturers who supply millions of dollars of the latest in electronics manufacturing equipment, is located at the EMPF. The ACI Equipment Advisory Board consists of representatives from many of the leading electronics manufacturing equipment firms in the country who provide guidance and resources to the EMPF. This partnership promotes successful technology transfer and deployment.



Training to industry and Government partners is provided at a training center located at the EMPF. In 2006, courses were offered in the areas of electronics manufacturing, certifications, skills, and professional advancement. These courses were available for all levels of the electronics manufacturing workforce and DoD personnel. Through the utilization of hands-on training on actual production equipment, these courses give the student the tools and techniques needed to increase efficiency in the workplace and to help assure the successful transition and implementation of ManTech-developed technologies.

#### **2.2.1.2 Prototype Integration Facilities (PIFs)**

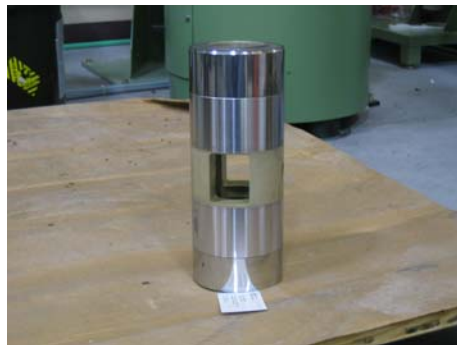
The Army ManTech Program interaction with PIFs fits within their overall mission to support the Program Managers/Program Executive Offices (PM/PEOs) and other organizations. PIFs support rapid prototyping, design, development, and integration of products into production. In 2006, ManTech impacted the PIFs located at the Aviation Missile Research Development and Engineering Center (AMRDEC) at Redstone Arsenal, AL and prototyping facility at the RDECOM ARDEC at Picatinny Arsenal, NJ. Some examples of how DoD ManTech developments were used within the PIFs are the following:

- The AMRDEC PIF implemented the JUMPED project (as discussed in section 2.2.1.1.2 above) to prototype and test a paperless machining system.
- The Army ManTech Program demonstrated the REM Chemical, Inc. process known as Isotropic Superfinish (ISF) which reduces contact and bending fatigue on gears used in helicopter transmissions. Testing concluded that gears processed using ISF actually performed better than new gears and were able to remove minor foreign object damage by uniformly removing a minimal amount of material on the gear teeth, while meeting all original equipment manufacturer specifications for dimension and geometry. The process enhanced surface quality and did not exhibit any detrimental metallurgical effects on the surface and sub surface of the gear tooth. ISF is currently being implemented (or qualification testing prior to



implementation) on Chinook, Apache, Black Hawk and Corpus Christi Army Depot and benefits include the following:

- There is reduced gear-induced noise and vibration amplitude with improved tooth surface topography;
  - A gear with ISF applied can be successfully used with non-ISF gearing in an assembly and is two-way interchangeable;
  - ISF processing does not impact gear parent material condition and/or quality;
  - ISF provides corrosion resistance capability, removing secondary processing such as black oxide, which leads to cost reductions
  - There is greater component performance capability and improved performance in marginal lubrication conditions.
- The AMRDEC PIF, located at the Huntsville, Alabama took the same ISF process as above and applied it to the CH-47 horizontal hinge pin (HHP) – a critical part that allows the helicopter main rotor blades to move up and down. The PIF has processed 24 pins that were returned to the field as usable assets. Currently 6 pins (2 heads) are undergoing flight test at Ft Rucker, AL and are being monitored for condition to determine the efficacy of ISF as a retardant to pitting initiation on the M50 material used on the HHP sleeves. Hours accumulated on each rotor head are 484 and 587, respectively. At 1200 hours the pins will be pulled and a detailed inspection of the HHPs will be performed at that time. To date, there are no issues with these pins.



- The U.S. Army RDECOM ARDEC transitioned advanced titanium processing technologies directly to the Warfighter. Titanium was the material of choice to protect the cupola gunner within the Stryker vehicle. ARDEC (using material and processes developed through Army ManTech funding) designed, fabricated, tested and fielded 406 sets of gunner cupola shields for Stryker brigades serving in Iraq. This effort used 80,000 lbs of single-melt material and incorporated high productivity welding developed under the Army ManTech Program. The cupola shield is currently being used in both the Iraq and Afghanistan theaters and has been directly attributed to saving Soldiers' lives. The ARDEC prototyping facility also provided the low cost titanium processes used to manufacture HMMWV gunner protection kits.

### **2.2.1.3 Other Execution Methods for Transition of Transformational Manufacturing Processes to the Defense Manufacturing Base**

The Services have established methods of transition planning to better ensure efficient transition of transformational manufacturing processes and technologies from the research stage to utilization by manufacturers in the defense manufacturing base. These include Technology Transition Agreements, Technology Transition Plans, and MRLs / maturation plans which are discussed below.

#### **2.2.1.3.1 Army Technology Transition Agreements (TTA)**

The Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology)(ASA/ALT), in a continuing effort to improve the Army's success rate with transitioning technology solutions, instituted a policy requiring TTAs for all Army Technology Objectives (ATOs). A TTA is intended to formalize and document the needs of the primary acquisition system/program for the key technologies being developed by the Science and Technology (S&T) community. The TTA focuses on specific deliverables with specified metrics and timelines. In 2006 the TTA process was initiated on all Army Technology Objectives for Manufacturing (ATO-M) programs in order to meet expectations of the customer and to assist in transition.

The TTA is developed jointly between the ATO Manager and weapon system Program Manager (PM). The ATO Manager defines the products that are to be delivered and the PM defines the product's performance metrics and helps define the demonstration parameters that will constitute acceptance. The process of TTA development starts at the beginning of an ATO and becomes an appendix to the acquisition program's Technology Maturity Assessment. In effect, the TTA links the ATO to the Warfighter.

The ATO manager provides the TTAs for their programs to the ASA/ALT Director for Technology for review and signature. One year prior to the end of the ATO, the ATO manager will brief the details of the TTA to the Warfighter Technical Council. Completed ATOs will provide the final version of the TTA as part of their close-out report. During 2006, Army ManTech ATO-M TTAs were coordinated between the FCS Lead Systems Integrator, RDECOM, the laboratory or Research, Development and Engineering Center (RDEC) and Project Manager, Future Combat System (Brigade Combat Team) Technologies for the following ATO-M's:

- Affordable ManTech for Structural and B(X) Armor
- Silicon Carbide Electronics
- High Power Lithium Ion Batteries
- High Energy Density Capacitors

In addition to the above, the ATO-M for Affordable Phase Shifters for Phased Arrays was integrated within the TTA for the Affordable Directional Antenna and Pointing Technologies. A TTA was signed in 2006. This TTA is with the Project Manager, Warfighter Information Network - Tactical (WIN-T) and is consistent with the WIN-T development strategy. ATO-M Ferroelectric Phase Shifters are utilized in low profile antenna prototypes for the WIN-T program. ATO-M Micro Electro Mechanical System (MEMS) Phase Shifters are being designed into semi-passive transmit phased arrays for PM WIN-T. These Phased Arrays can be fabricated with a 2:1 to 4:1 cost reduction over conventional arrays requiring monolithic microwave integrated circuit amplifiers at each element due to the low loss of the MEMS Phase Shifters.

#### **2.2.1.3.2 Navy ManTech Technology Transition Plans (TTP)**

Navy ManTech projects are developed in conjunction with industry and the acquisition program office. Planning for transition prior to the initiation of projects is critical for the implementation of technology on the factory floor and eventually into the Fleet. The PEO/PMs and relevant industry partners are encouraged to participate in an initial concept exploration phase – an assessment of the manufacturing processing needs of the weapon system. Most importantly, this includes the determination of whether the ManTech projects have a high likelihood of successful completion in time to meet the “window of opportunity” for insertion into the weapon system. Highest priority manufacturing opportunities are selected.

In addition, each PEO/PM is expected to provide personnel with technical expertise and/or management experience to assist the Navy ManTech Program Office in project oversight. This support affords assurance that the weapon system PM is truly committed to the successful outcome of the Navy ManTech project. In addition, this close working relationship between the parties provides Navy ManTech with a longer-term view of implementation.

To clarify communication between the entities and to increase the likelihood of implementation, the Navy ManTech Program instituted the development of a TTP for each project. The TTP is a result of cooperative interaction between the Navy ManTech office, the Navy COE, the industrial facility where the technology will be implemented, the weapon system program office and, as appropriate, the Technical Warrant Holder. For Navy ManTech purposes, *transition* denotes that point at which the ManTech project is completed and the technology meets customer (Weapon System Program Office / Industrial Facility) criteria and goals for implementation. *Implementation* denotes the actual use of ManTech project results on the factory floor. Navy ManTech Program results are typically implemented by entities other than Navy ManTech such as the Program Office and/or industry.

The Navy ManTech Program cannot alone ensure implementation, but a well-defined TTP assists the Weapon System Program Office and Industrial Facility Management in supporting transition and achieving implementation. The TTP includes a description of the resources to be supplied by the weapon system program office and / or the industrial facility to provide the test, evaluation, certification, and/or other services necessary to achieve implementation.

#### **2.2.1.3.3 Air Force Application Implementation of Manufacturing Readiness Levels (MRLs) for Improved Transition**

The Air Force recognizes manufacturing maturity as an essential element in assuring successful technology transition for hardware-intensive technologies. Manufacturing Readiness Assessments (MRAs) and maturation plans using MRLs are becoming a standard requirement for transition planning of Manufacturing Technology projects, Advanced Technology Development (ATD) programs and other high-visibility technology efforts within the Air Force S&T Program. In a significant shift, managers of ATDs and other high visibility programs are now responsible for establishing and managing both the performance maturity and the manufacturing maturity of their technologies to increase the probability of successful transition into weapon system applications. Transition customers are now involved in setting manufacturing maturity requirements for transition. Results of manufacturing readiness assessments, as well as progress in executing manufacturing maturity plans are reported at senior management program reviews.

## **2.2.2 Dissemination of Enhancements**

The JDMTP continues to work closely with its industry associates to discuss issues related to high-performance defense manufacturing technology research and development. In particular, the DoD ManTech Program and the JDMTP coordinated with industry in FY06 to advance manufacturing technology through the following groups: (1) the Manufacturing Extension Partnership (MEP) Program; (2) JDMTP working groups to identify incentives for industry to incorporate and utilize advanced manufacturing processes and technologies; (3) Government/industry partnerships to develop technology and share data; and (4) other manufacturing best practices organizations. Methods used to enhance and disseminate advanced manufacturing processes and technologies to the defense manufacturing base through these groups are discussed below.

### **2.2.2.1 Manufacturing Extension Partnership Program**

DoD ManTech and the ODUSD (AS&C) / OTT uses the expertise and services of the DoC/NIST MEP to help small U.S. manufacturers and Defense suppliers in their efforts to design, manufacture and produce products that DoD needs to enhance the capabilities of U.S. Warfighters. MilTech, a MEP affiliate and member of the Office of Technology Transition's Partnership Intermediary Network, acted as an intermediary to coordinate the delivery of specialized business, engineering and technical assistance to Defense suppliers according to DoD supply needs and priorities. MEP's private not-for-profit Centers worked with MilTech to provide customized and hands-on assistance in converting technologies into viable products that met quality, delivery and supply requirements of Defense acquisition. As a technology transition intermediary, MilTech supported DoD in all aspects of technology transition, and often engaged the local MEP Center for specialized on-site assistance – Design for Manufacture/Assembly, Quality systems, Lean & Six Sigma, workforce development, project management, supply chain, plant layout and process improvement, new product development and technology deployment.

Various defense technology transfer/transition programs and initiatives also employed the expertise and services of the MEP and its national network of over 1200 business, engineering and manufacturing specialists located in every state and Puerto Rico. MEP specialists often contributed their expertise and experience in program development activities such as the DoD ManTech Lean Battery Initiative, Manufacturing Readiness Assessments, supply chain optimization, supplier and workforce development, Lean and Six Sigma training and implementation, Quality Systems and many other Defense-sponsored manufacturing improvement and technology transition programs.

The Air Force ManTech Program has engaged MEPs to participate in ManTech programs aimed at bringing Lean practices to first and second tier suppliers for key acquisition programs. They found this approach to be very effective in creating cost and schedule benefits as well as creating needed capacity for supply surge and sustainment.

### **2.2.2.2 Incentives for Contractors**

The risks associated with implementing new manufacturing technologies can be a significant barrier to the defense manufacturing industry. Because the DoD ManTech Program addresses advanced manufacturing technologies that are beyond the normal risk of industry (per U.S.C., Title 10, Section 2521), ManTech investments by the Services and Agencies are a significant influence (e.g., incentive to contractors) in promoting implementation of advanced manufacturing processes and equipment in the defense manufacturing base.

JDMTP discussed the issue of contractor incentives with various industry groups – the NDIA, NGMTI, and NCMS – during FY06. The discussions included specific

contracting strategies to provide incentives to industry to implement manufacturing technologies. Some contracting strategies to “incentivize” contractors might be the use of Cost Plus Incentive Fee contracts that pay an additional fee funds for a contractor’s early delivery due to the use of efficient manufacturing technology development tools such as Lean or Six Sigma. Contractual incentive fees might also be paid to contractors who address, for example, total ownership cost during program formulation, with identification of cost drivers, consideration of unit price targets, and use a mechanism to track total ownership cost with handoff to the acquisition customer. Other incentives might include Government and industry cost sharing of capital equipment for critical military manufacturing needs, joint programs and funding by multiple Services and Agencies to provide adequate funding to carry a product through to implementation, and the use of technology transition agreements and technology transition plans to better enable contractors and the Government to function as a team throughout the manufacturing development process.

Some Army contracts require the use of MRLs as an incentive to contractors to reduce program risk. For example, the Army has integrated MRLs into some program contractual documents. At a minimum, contract deliverables on some efforts are tied to criteria to define a particular MRL level. This ensures that the contractor has a clear understanding of the product manufacturing maturity and risk as it progresses through development and demonstration of a product. By using manufacturing criteria in contracts, both the Government and industry can manage manufacturing risk on one or two immature areas while providing visibility of manufacturing maturity for the rest of the system.

### **2.2.2.3 Government / Industry Partnerships for Development of Technology and Sharing of Data**

DoD ManTech’s mission is to mature and validate emerging manufacturing technologies to support low risk implementation in industry and DoD facilities. Because prototyping and various engineering stages of manufacturing are expensive, the DoD ManTech Program establishes partnerships with DoD and industry at collaborative facilities to reduce the risk, cost and time of development for critical technologies important to national defense. Some examples of these partnerships created to leverage the resources of multiple organizations are found below.

#### **2.2.2.3.1 Lean Battery Initiative**

The LBI is an excellent example of DoD ManTech’s insight, forward-thinking and ability to integrate multiple efforts into a single program. The result of this “purple” approach was that the integration of the resources from various agencies resulted in program success that would not have been achievable if each piece was implemented independently.

The LBI provided industrial base-wide process improvements of 300% that cut across three battery producers. With improved operational readiness, the battery manufacturing base is now more capable of responding to sharp fluctuations in battery demand. The joint investment leveraged Army funds of \$5M made during 2003 and benefited from the battery technical expertise provided by the Army and the other agency members of the JDMTP-sponsored Battery Manufacturing (BATTMAN) Initiative Study Team (that served as a precursor and catalyst for establishing LBI). OSD provided \$400K and MDA provided \$200K funding for Lean/Six Sigma facilitation. The DLA WarStopper Initiative provided over \$11M dollars to the battery producers to support implementation of quick ramp-up capability, such as pre-positioned components and equipment. Independently, the three battery companies provided \$13.240M investment in equipment and manpower resources. Finally, the JDMTP provided program oversight and feedback throughout. The result of this joint

investment is a battery industrial base that is capable of supporting the Warfighter as well as commercial needs for batteries.

#### **2.2.2.3.2 Flexible Display Center (FDC)**

The FDC at Arizona State University is a university / Industry / Government collaborative venture designed to advance full color flexible display technology and flexible display manufacturing to the brink of commercialization. Displays for situational awareness in daylight, night, and adverse weather depend on glass-based, commercial technologies. However, an integrated pilot line to manufacture affordable flexible displays does not exist anywhere in the world.

The Army ManTech Program established the FDC in February 2004 to spearhead the next revolution in information displays and to establish an integrated pilot line and processes to manufacture affordable flexible full-color active matrix displays. The Center is a partnership where academia, industry, and Government collaborate on rapid technology development, innovation and integration to create a new generation of innovative displays that will be flexible, lightweight, low power, and rugged. These revolutionary displays will usher in a new era of powerful real-time information sharing through ubiquitous commercial and military application in everything from portable pocket-held and vehicle-mounted devices to permanent and temporary conferencing / command rooms.

The principal goal of the FDC is to develop high performance, commercially-viable, conformal and flexible displays that are lightweight, rugged, low power, and low cost.

***World's First flexible display pilot line tools:***

***(1) Photoresist spray coater (now commercialized)***



***(2) Photolithography with automatic substrate distortion compensation***



***(3) Cluster deposition with active substrate cooling.***

#### **2.2.2.3.3 Composites Affordability Initiative (CAI)**

The CAI program was established in the late 90's to reduce the cost of composites for transition to airframe structures. The CAI team consists of the Air Force Research Laboratory Materials and Manufacturing Directorate, the Air Vehicles Directorate, the Navy's Office of Naval Research, Boeing, Lockheed Martin, and Northrop Grumman. The entire industrial base of aerospace primes as well as the Air Force and the Navy agreed data rights for all technologies developed under the program would be restricted just to the CAI team due the extensive industry cost share. Furthermore, data to support transition to specific air platforms was only shared between the government and the CAI team member who was the owner of the transition target as needed (e.g., Lockheed Martin had sole data rights on their Joint Strike Fighter Demo Program).

However, as the CAI program wound down in 2006, it became apparent that only the structural analysis and cost analysis tools were transitioning. Therefore, the government persuaded the industry team to open up data rights to all United States

Government (USG) contractors. As a result, there was a final program review of the entire shared effort that was open to industry. The final reports were stamped with “USG” and “USG contractor dissemination”. The Government CAI team has been aggressive in publishing CAI summaries in the manufacturing trade journals and technical conferences which has resulted in queries from non-CAI companies who want to discuss data for future programs. Also, a CAI program database was developed that is available to the USG and its contractors. The database contains mechanical property test data that is traceable back to the process that produced it and lists the processing parameters used as well as the material and its integrity. This interrelationship between materials, processes and performance produces a legacy of data that facilitates the transition of composite materials and processes to industry.

#### **2.2.2.4 Other Manufacturing Best Practices Organizations**

The DoD ManTech Program leverages the resources of other manufacturing technology organizations and consortium that provide a mechanism to share information on best manufacturing practices. These other resources of information on best practices and advanced manufacturing processes and technologies are found below.

##### **2.2.2.4.1 Best Manufacturing Practices Center of Excellence (BMPCOE)**

The BMPCOE – a partnership of the Navy ManTech program, DoC, and the University of Maryland at College Park – was established in 1993. It is a national resource that provides Best Practices, Systems Engineering, and Web Technologies that enable defense and commercial customers to operate at a higher level of efficiency and effectiveness. The BMPCOE helps businesses identify, research, and promote exceptional manufacturing practices by conducting unique on-site surveys of contractor and Government facilities to identify best manufacturing practices based on the organizations’ voluntary sharing of information. To date, hundreds of surveys have been conducted, thousands of practices documented, how-to-guidelines published, and a Web site established to make the BMP program’s resources easily accessible. The validated best practices are easily and readily accessible, and are the heart of the BMPCOE’s Program Manager’s Workstation that is an electronic suite of tools designed to provide timely acquisition and engineering information so users can make informed decisions. The BMPCOE has also established a proven Web-based fifth-generation Collaborative Work Environment that adapts to organizational processes and culture and can be tailored to users’ needs and functions.

Through its nine regional Satellite Centers, BMPCOE serves the entire defense manufacturing base. The Satellite Centers were established as an extension of BMPCOE to provide representation and awareness of BMPCOE’s mission, tools, and resources. Responsibilities of the Centers include participating at conferences and exploring opportunities for potential surveys and team members. The BMPCOE Web site that receives tens of thousands of hits per day is located at: [www.bmpcoe.org](http://www.bmpcoe.org).

##### **2.2.2.4.2 Manufacturing Technology Information Center (TIC)**

The Air Force TIC provides services to meet the information management and technology transfer needs of the Air Force Materials and Manufacturing Directorate. TIC helps facilitate information dissemination and technology transfer of advanced manufacturing process and technology data in conjunction with a national network of technology transfer organizations. In FY06, a variety of marketing efforts were employed that included preparing news releases, success stories, brochures, pamphlets, news letters, posters, displays and exhibits, and placing information on the Air Force ManTech Web Site located at <http://www.ml.afrl.af.mil/>. Information is disseminated and contact information is placed on all of the products developed by the Air Force – as a direct result of this service, the Air Force received frequent requests from a variety of sources from the defense manufacturing industry, academia, and other military



organizations to obtain additional information on a manufacturing project or to speak with a subject matter expert. The TIC assisted in fielding these requests and in putting the appropriate person in touch with the requestor. These efforts resulted in successful transition and transfer of technology and numerous collaborations throughout the year.

#### **2.2.2.4.3 Combat Rations Network (CORANET) Program**

CORANET is a “community of practice” engaging academic and industrial research partners with the diverse collection of Government agencies and programs that oversee and administer the development, production and distribution of military rations. These rations include individual rations such as Meals Ready to Eat (MREs) as well as unitized group rations.

In FY06, CORANET focused on enhancing producibility and manufacturability of combat rations to improve line speed, maintain quality, and reduce cost. The combat rations industrial base is small, and military specifications preclude the use of most commercially- available products. DLA realized that it was critical to keep all of the parties in the combat rations supply chain engaged to insure the continuing production, safety, and quality of combat rations while controlling ration cost. All of the CORANET participants met at regularly scheduled workshops. They worked collaboratively to identify problems and needed improvements and to define solutions. Research solutions were demonstrated and implemented through short term projects conducted by academic partners, assisted by industry partners and overseen by the appropriate Government representatives.

#### **2.2.2.4.4 Procurement Readiness Optimization – Forging Advanced Systems Technology (PRO-FAST) Program**

The Forging Defense Manufacturing Consortium (FDMC) – which is the teamed relationship between the Forging Industry Association, North America's sole forging industry trade and technical association, and the Advanced Technology Institute (ATI) – represents nearly 70% of the U.S. Forging Industry. Working closely with DLA through the PRO-FAST Program the consortium developed and deployed a host of collaborative technologies and tools to support the forging industrial base in the production of short run spare part production for the Warfighter.

In FY06, the PRO-FAST Job Shop Lean Project, led by The Ohio State University, directly affected short run production of spare parts. Graduate students were deployed within forges for 90 day assignments that typically resulted in improved forging supplier performance with respect to short run productions that are associated with spare part procurements. The PRO-FAST program placed students in several forges across the country resulting in significant reductions in lead time and quicker production of spare parts. The program's development and deployment of PRO-FORGE with Sikorsky Aircraft provided an innovative, teamed approach for addressing both new and legacy forged parts. At Sikorsky, PRO-FORGE solved problematic spare part requirements for the DLA and other Sikorsky customers. The PRO-FAST Program, supported at the Defense Supply Centers in Richmond, VA and Columbus, OH, provided direct problem part resolution as that resolved material supply issues related to the A-10 Aircraft Wing Splice Procurement in the spring of 2007. All of these successes were enabled through the FDMC collaborations between Government and industry.

#### **2.2.2.4.5 Procurement Readiness Optimization – Advanced Casting Technology (PRO-ACT) Program**

DLA's PRO-ACT program develops and applies innovative technologies and new processes to advance the rapid acquisition, quality, and cost-effectiveness of metal



castings. The program is led by the American Metalcasting Consortium (AMC), consisting of the four leading metal casting industry associations, their industry members, the leading metal casting research universities, DLA, and ATI as the program manager and prime contractor.

In FY06, AMC represented every major casting process and material, ensuring a balanced portfolio of research projects addressing DLA's needs and ensuring direct industry applicability and rapid deployment. The AMC also avoided the risks of pursuing a single technology, which even if technically and commercially successful, would only impact a single point of the DLA's multifaceted casting procurement requirements. AMC's CAST-IT team of engineers provided direct technical and procurement support to DLA's Defense Supply Centers.

## **2.3 MANUFACTURING TECHNOLOGY STRATEGIES (SECTION 243)**

Many of the best methods, products, processes and capabilities that emerge from industry competition and innovation can be adapted to develop and produce military goods. The USD (AT&L) is aware of the benefits of teaming Government and industry manufacturing experts to conduct technology roadmaps that define strategies for the development of advanced manufacturing processes and technologies in high-payoff defense manufacturing base investment areas. In FY06, the JDMTP and NDIA worked together to develop industry-prepared roadmaps that are discussed below.

### **2.3.1 Identification of Common Area to Roadmap**

In late 2005, the JDMTP assessed key areas of technology where the development of an industry prepared roadmap for manufacturing and technology processes applicable to defense manufacturing requirements would be beneficial to the DoD. JDMTP chose electronics as the initial area of focus for technology roadmapping. Joint roadmapping of this type has not been attempted before by the DoD ManTech Program and so JDMTP prototyped the electronics technology roadmap in two areas to determine which method would most efficiently and reliably identify high-payoff investment areas, actionable plans and compelling business cases. The task of overseeing the roadmap development was assigned to the Electronics Sub-panel of the JDMTP which selected Power Sources and RF Modules as the first two topic areas. Two Technical Working Groups (TWGs) were formed for each of these areas and the groups were given responsibility to develop the technology roadmaps. The focus for the Power Sources topic was defined as "uninterrupted provision of portable power for the Warfighter". For RF Modules, the challenge was to "improve the quality of communications, discernment of potential targets, and power delivery for electronic warfare."

### **2.3.2 DoD/Industry Task Force to Roadmap Manufacturing Strategy**

In February 2006, the Power Sources TWG convened a two-day technology roadmapping workshop with approximately 100 selected experts from industry, academia, technology suppliers, DoD, and other Government organizations. The RF Modules workshop was held in May 2006 with approximately 60 invited experts who represented all aspects of RF module development. A similar format was followed for both workshops to identify critical needs and solution options. Initial technology roadmaps for both topics were published in the summer of 2006. JDMTP relies on a strong alliance with industry to fulfill the leadership role in managing roadmapping activities. The Manufacturing Committee of the NDIA volunteers on a regular basis to participate with the JDMTP as a sounding board for ideas, a source of expert knowledge, and a review panel for prepared roadmaps. The NDIA and others are engaged, as appropriate, in the manufacturing technology selection and roadmapping process.

### **2.3.3 Commencement of Roadmapping**

The Power Sources and the RF Modules roadmaps were both completed and delivered to JDMTP in the summer of 2006. It is planned to refine and update these roadmaps and to develop detailed project plans for these roadmaps in FY07 and FY08. The process continues – the USD (AT&L) in concert with the JDMTP identified Orthotics and Prosthetics for wounded soldiers as the next critical topic for technology roadmap planning and development. Contracts were put into place to fund development of three additional topics to be identified and addressed in FY07 and FY08. Other future roadmap technology areas for review are wide band gap components, lithium ion batteries for hybrid power applications, composite benchmarking study, model-based enterprise, and electronics affordability for shipbuilding.

## **3 EFFECTIVENESS OF ACTIONS AND IMPLEMENTATION OF ACTIONS WITHIN DEFENSE MANUFACTURING BASE**

As reported in the U.S. Government Accountability Office Report dated March 2005, *Defense Acquisitions: Assessment of Selected Major Weapon Systems* – a successful program is one that has mature technologies and stable designs with mature production processes in control. Further, the Defense Science Board (DSB) noted in its 2006 report on *Manufacturing Technology: A Key to Affordably Equipping the Future Force* that DoD ManTech can address critical development, acquisition, and sustainment problems of advanced weapon systems because the Program: (1) impacts all phase of acquisition; (2) facilitates technology transition; (3) has demonstrated significant reductions in cost and cycle-time and increases in reliability; and (4) has demonstrated tremendous return on investment. USD (AT&L) supports the GAO and DSB assessments.

The DoD ManTech focus is to develop responsive, world-class manufacturing capabilities that provide affordable and timely solutions to the Warfighter. DoD ManTech works directly with the defense manufacturing base to develop these capabilities and to transition needed products to the Warfighter. In FY06, DoD ManTech effectively implemented high-performance defense manufacturing technology actions in the defense manufacturing base in three key areas of Lean development, MRLs, and roadmapping efforts in the areas of power sources and RF modules.

### **3.1 Faster Surge Capabilities with Lean Battery Initiative**

The LBI successfully solved problems related to critical batteries used by our Warfighters. LBI increased the use of automation and more efficient production processes in order to reduce the number of manual production operations – a primary source of product defects and delays. The LBI enabled faster surge capabilities and defense manufacturing industry-wide process yield improvements of 300%. LBI eliminated the battery shortages that impacted combat operations during Operation Iraqi Freedom.

Improved battery manufacturing technology was fully implemented in the defense BA-5590/BA-5390 manufacturing base. As a result of LBI, the industrial base is capable of producing 25% more battery cells per month than the previous capacity of slightly over 1,500,000 cells / month. The ability to surge to maximum production capacity has decreased from six months to four months due to 25-45% decrease in production and test throughput times and first-past yield improvement of almost 20%. These LBI efforts ensure the battery industrial base will never again be a limiting factor in supporting the Warfighter.

### **3.2 Improved Technology Implementation with Manufacturing Readiness Levels**

In FY06, JDMTP successfully worked with industry to develop MRLs and associated tools such as the MRL Guidebook and Deskbook, the *MRL-Assist* web-based tool, and

the DAU MRL online reference material. MRLs are an effective tool to enable rapid, affordable transition of technology to weapon systems programs and to assess the manufacturability (e.g., risk and maturity) of a product. MRLs and manufacturing readiness assessments foster better decision making, program planning and program execution through improved understanding and management of manufacturing risk.

MRLs and equivalent manufacturing readiness assessments are being implemented in the defense manufacturing base. Joint DoD/industry MRL workshops held in FY07 and planned in FY08 are refining the existing MRL definitions and obtaining feedback from Government and industry participants on the definitions and an associated manufacturing readiness exit criteria matrix. The DoD ManTech Program plans to continue to work with industry to confirm that correct activities flow through the MRL criteria matrix for alignment with the DoD 5000 acquisition process schedule requirements.

### **3.3 Roadmapping and Strategic Planning to Identify DoD/Industry Partnership Areas**

JDMTP effectively coordinated with industry in FY06 in strategic planning of the DoD ManTech Program through its roadmapping activities in the areas of RF Modules and Power Sources. Initial technology roadmaps for both topics were published in the summer of 2006, and maturation of plans and development of additional project plans are planned (e.g., orthotics and prosthetics) in FY07 and FY08. In addition, the Services and DLA ManTech and MDA Manufacturing and Producibility program plans were successfully coordinated with the joint ManTech community – including industry – through the JDMTP in its annual Portfolio Reviews. These reviews effectively assure that efforts are not duplicative and obtain a joint perspective as to the priorities of the defense-wide manufacturing investments.

JDMTP continues to effectively coordinate with multiple manufacturing industry groups – for example, NDIA, NGMTI, NCMS, and the Navy COEs – to identify, prioritize, and implement critical manufacturing technologies, opportunities for partnership, and incentives for contractors in the defense manufacturing base to incorporate and utilize manufacturing enhancements in their manufacturing activities.

## **4 RECOMMENDATIONS**

The USD (AT&L) provides the following recommended actions to continue to increase the effectiveness of enhancing manufacturing activities within the defense manufacturing base.

### **4.1 Conduct Roadmapping**

The USD (AT&L) recommends continuing efforts to conduct roadmapping through the JDMTP and its Sub-panels. Priorities should be determined based on the ability of the technologies to be transferred across multiple platforms and the defense manufacturing industry. Additional manufacturing technology areas planned for future roadmap review are orthotics and prosthetics, wide band gap components, lithium ion batteries for hybrid power applications, composite benchmarking study, model-based enterprise, and electronics affordability for shipbuilding.

### **4.2 Coordinate with Industry**

The USD (AT&L) recommends continued coordination with industry associations to assess the effectiveness of activities to enhance manufacturing activities within the defense manufacturing base. The JDMTP should continue to collaborate with multiple industry groups to discuss advanced manufacturing process and technology opportunities for partnership. JDMTP should work with industry to continue to develop an overall balanced portfolio of manufacturing technology programs that address

reduced cost and risk, individual and multi-Service applications, research in “disruptive” technologies, and manufacturing-related SBIR topics.

#### **4.3 Work with Defense Acquisition University**

The USD (AT&L) recommends that manufacturing-technology related courses and Web site resources continue to be developed and maintained to provide the necessary knowledge and skills for the DoD ManTech community and the defense manufacturing base. JDMTP should continue to work with the DAU to develop and refine curriculum on advanced manufacturing technology, manufacturing readiness, and affordability.

#### **4.4 Host Workshops and Conferences**

The USD (AT&L) recommends JDMTP host more workshops with defense industry associations (e.g., through NCAT and with NDIA) to identify opportunities and elevate defense manufacturing industry issues. Agendas should include topics such as greater proliferation of manufacturing technology into the defense manufacturing base, implementation of MRLs, and appropriate incentives for successful transition and implementation of advanced manufacturing processes and technologies by defense manufacturing contractors. In addition, key USD (AT&L) leaders should continue to be involved in the annual Defense Manufacturing Conferences in order to positively impact the overall defense manufacturing industry.

#### **4.5 The Bottom-Line**

The OSD, Service, and DLA ManTech Program Directors and the MDA Director of Manufacturing and Producibility should continue to focus on the important values of affordability, coordination with the defense manufacturing industry, and Warfighter relevance in their planning activities. The JDMTP should continue its coordination with the joint ManTech community – the Services, Agencies, and industry – for example, through its annual Portfolio Review and other strategic planning activities. These activities will enable the ManTech community to get a joint perspective on overall manufacturing investments in order to obtain a diverse and balanced portfolio to meet the future defense manufacturing needs of the United States.

## APPENDIX

### FY06 Advanced Manufacturing Processes and Technology Highlights

As shown in the table below, FY06 funding for the Services and DLA ManTech programs totaled about \$252M. In addition, MDA funded \$30M for its MP Program. The OSD ManTech funding line (i.e., 0603680DW) was not yet funded in FY06.

#### FY06 Service and DLA ManTech Funding

| \$M       | PE       | FY06    |
|-----------|----------|---------|
| Air Force | 0708011F | 56.7    |
| Army      | 0708045A | 101.2   |
| Navy      | 0708011N | 57.7    |
| DLA       | 0708011S | 35.9    |
| Total     |          | \$251.5 |
|           |          |         |

The ManTech programs of the Services and DLA, and the Manufacturing and Producibility Program of MDA conducted R&D on processes and technologies that addressed advanced manufacturing processes and technologies in the areas of (1) electronics; (2) metals; (3) composites; (4) sustainment and readiness; and (5) extended production enterprises using information technology. Some highlights of research and development conducted in these areas are found below.

#### 1. FY06 Electronics Processing and Fabrication Highlights

##### Dual Band Focal Plane Arrays Manufacturing

Improved third generation infrared sensors are needed to detect threats at increased ranges and to allow units on the move to rapidly search areas. Key to achieving this capability are dual band focal plane arrays that enables an infrared system with the advantages of mid and long wavelength bands simultaneously. This technology helps find targets faster and reduces Warfighter fatigue. The Army ManTech Program invested funds to produce a better infrared system at a lower cost. The program reduced the cost of focal plane arrays from \$705,000 to \$17,000 for one format and from \$1,605,000 to \$60,000 for another format. In addition, the program helped reduce the weight of the infrared sensor system relative to existing systems. This technology will benefit platforms that utilize dual band systems such as the Long Range Advanced Scout Surveillance Suite (LRAS3), Stryker, Future Combat System (FCS), Apache helicopter and Armed Reconnaissance Helicopter. Implementation for LRAS3 in Iraq is expected during 2008.

##### *Better Infrared Systems at Lower Cost*



##### F-35 Infrared Focal Plane Arrays (FPAs)

Air Force F-35 Infrared FPAs provide critical image data to the Warfighter, yet account for seventy-five percent of the total cost of the Infrared Detector Assembly system of

which there are seven per aircraft. Air Force ManTech reduced the overall cost of the F-35 infrared system that by working with its two contractors to successfully manufacture and implement lower cost, larger-scale Indium Antimonide (InSb) wafers with reduced cluster defects. One contractor achieved significant improvements in InSb focal plane array yield, improving from 47 percent passing yield to 78 percent passing yield with decreased cluster defects. The other contractor invested funds to buy capital equipment to produce larger scale wafers and successfully worked with the Air Force to transition from three-inch diameter wafers (with just three die) to four-inch diameter Grade A wafers (i.e., wafers free of cluster defects larger than eight pixels) with five die. The labor involved in wafer processing is relatively constant, so the increase in the wafer diameter and yield of die equates to an increase in productivity and lower costs. The Air Force achieved its goal to produce four-inch diameter InSb wafers and achieved a direct cost avoidance of about \$400 million in the F-35 Program.

### **Next Generation Sensor Producibility Flight Experiment Program**

MDA initiated the Next Generation Sensor Producibility Flight Experiment Program as a test vehicle program in which the goal is to develop fast tracking technologies to provide capability enhancements for specific MDA programs at reduced cost and schedule. An objective of the program is to prove out technology early in order to provide timely MDA program block upgrades. The first in a series of Flight Experiments – designated NGSP-FE-1 – involved industry partners who worked to assess the viability of a Silicon Carbide Telescope designed by Raytheon Missile Systems and manufactured by Poco Graphite. Other industry partners included Miltec Corporation who provided the systems engineering support, Battelle who provided the objects for viewing, and Axsys Technologies who built up the telescope and integrated a visible sensor for delivery to Raytheon. In addition to this telescope evaluation, Luna Innovations looked at the viability of using a common electronics interface card to allow plug and play capability for various sensor packages. Secondly, a flight experiment was conducted that utilizes traveling wave tube (TWT) technology – versus S-Band system technology – to obtain higher bandwidth. NASA Wallops Flight Facility supported this MDA effort using a TWT, developed under SBIR funding by AmpWaveTech, to demonstrate the ability to deliver 200 Mbps to the ground station for the experiment data link. Lockheed Martin and CPI are industry partners in this endeavor as well. The success of this effort will provide the MDA test community with a new level of high bandwidth data collection capability never before available.

## **2. FY06 Metals Processing and Fabrication Highlights**

### **Mobile Drilling Kits for Field Use**

The process of drilling holes to install armor plates has typically been time consuming and costly and most field workers had had limited access to machining equipment normally required to conduct installation. The NCDMM at Rock Island Arsenal, Illinois, provided a successful solution to drilling holes in materials that range from aluminum, to thin sheet metal to armor plating. NCDMM specially designed Mobile Drilling Kits for general drilling operations on armored vehicles using carbide bits to successfully penetrate armor. The kits were designed to be easily shipped to Warfighters in areas of operation and contain common tools for all technicians (e.g., same drills and batteries for consistent tooling), a drill sharpener to use on-site to sharpen bits, and user-friendly training information. A total of 745 kits were assembled and delivered to the Rock Island Arsenal in IL and the New Cumberland Distribution Center in MD at a cost of \$3.6M.

## **Virtual Reality for Welder Training**

This Navy ManTech project demonstrated virtual reality as a viable technology to train welders in the joining of high value components. The welding training system consists of a welding torch attached to a force feedback device, a head-mounted display, a six degree of freedom tracking system (for both the torch and the user's head), and external audio speakers. The head-mounted display provides a 3D view with real-time student feedback including a ghosting mode that shows the welder where the torch should be positioned in time and space. The resulting welding trainer is now commercially available and has been purchased by Northrop Grumman Newport News (Navy), Aberdeen Proving Grounds (Army), BAE/United Defense Ground Systems (Army), South Dakota School of Mines and Technology (Army), and the California Penal System.

## **Weld Quality Control SBIR/Navy ManTech Transition**

WeldQC, Inc. (a small business in Columbus, OH) was working in 2006 on a Phase II SBIR award to develop a web-based software system that significantly reduces the costs associated with the development and review of welding procedures and welder performance qualifications that satisfy the various U.S. Navy welding specifications. The Navy ManTech Program is now funding follow-on work at its Navy Metalworking Center which will leverage the effort done on the prototype system developed under the SBIR project; extend its capabilities and cost savings; and work towards transition / implementation of this technology for both CVN 21 and the VIRGINIA Class Submarine. This ManTech follow-on effort is also being funded by Northrop Grumman Newport News, General Dynamics Electric Boat, and PMS 378; thereby increasing the probability of implementation of this system on the factory floor.

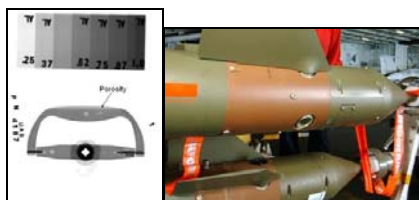
## **Radiographic Images for Guided Bomb Units (GBUs)**

DLA ManTech developed a radiographic reference image standard for use with digital images of aluminum castings. The lead time and economic benefits of digital radiographic inspection were so attractive to metalcasters that digital radiography was used on a provisional basis for certain weapons systems, including the GBU 10, 12, and 16. Some of the benefits of this technology were:

- A significantly higher probability of detection compared to single wall film (94% vs. 79%)
- Shorter inspection times (12 minutes vs. 2-3 hours) and lower recurring costs

A premium quality aluminum casting producer estimated that 5% of casting cost is in radiographic film expense. One heavily inspected part realized a savings of \$265,000 per year.

### ***Digital Radiography Reduces Probability of System Failure***



***Radiographic images for GBU***

### **3. FY06 Composites Processing and Fabrication Highlights**

#### **Low-Cost Lightweight Structures for the Blackhawk and Chinook Helicopters**

The Army ManTech Program invested in manufacturing low cost, lightweight composite structures for helicopters. Manufacturing processes were demonstrated under a Manufacturing Technology Objective project managed by the Army RDECOM AMRDEC. Improved composite manufacturing processes and lightweight X-Cor(TM) and K-Cor(TM) materials were demonstrated that reduce the cost of the UH-60 aircraft from \$166K for the metal baseline to \$86K per aircraft due to composite replacement of the aircraft's tailcone. An overall weight reduction of 50 lbs per aircraft was achieved. A lighter weight composite driveshaft was also developed on this technical effort, and it is planned to develop a forward pylon for the CH-47. The composite tailcone and driveshaft are programmed for UH-60M Block 1A production during FY08. The composite forward pylon will be inserted into the CH-47 F Model first Multi-year aircraft delivery scheduled for 2009. The project leveraged significant additional funding from the DAC program, industry, and acquisition program manager cost share. Recurring costs have been reduced from \$142K to \$82K. Projected benefits are \$115M. Recurring costs have been reduced from \$142K to \$82K. The Blackhawk and Chinook program management offices have been an integral part of the DoD ManTech management team for this project, and their participation ensures that ManTech processes will transfer to production.

*Low Cost Lightweight Tailcones Produced for the Blackhawk*



#### **Low-Cost, Large Pultruded Composite Panels for Ship Structures SBIR / Navy ManTech Transition**

KaZak Composite, Inc. (a small business with operations in Massachusetts and New Hampshire) was working in 2006 on the low-cost, large pultruded composite panels for ship structures project. Specifically, this was a SBIR Phase II award to develop low-cost, large (10 ft wide by 100 ft long) pultruded structural panels for the DDG 1000 deckhouse design. This Phase II is actually being extended by PEO(Ships) for evaluation of pultruded panels for the Peripheral Vertical Launch System on the DDG 1000. The Navy ManTech Composites Manufacturing Technology Center has been keeping abreast of this development effort and is currently evaluating a proposal to extend (utilizing ManTech funding) the work done on pultruded panels (additional panel construction as well as joint design and testing) to fully certify the process as an alternative to the costly VARTM process currently in the DDG 1000 baseline design.

#### **Improved C-17 Aircraft Main Landing Gear (MLG) Doors Durability**

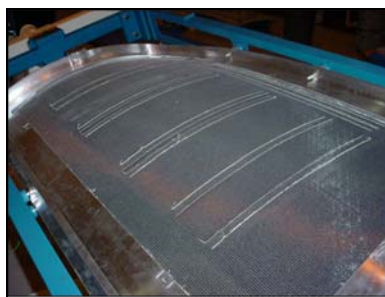
C-17 MLG door failures had become a major contributor to reduced aircraft mission capability due to delaminating outer skins, portions departing from the aircraft during flight, and foreign object damage on the leading edges during landings on unimproved runways. Extensive man-hours were being spent on field level repair to correct the problems, thereby decreasing mission readiness by over 90 days per year. Necessary



repair of the MLG doors was the fourth leading cause of system down time and the number one cause of airframe downtime. The Air Force ManTech Office and the Air Vehicles Directorate, in cooperation with The Boeing Company, successfully developed and implemented a durable composite C-17 MLG door. As a result of this CAI C-17 technology transition demonstration program, the MLG door developed an improved design that featured stitched preforms, and vacuum assisted resin transfer molding. Based on improvements incorporated in the design, engineers estimate there is an approximate 40 percent increase in reliability of the new MLG doors. In addition, there is no adverse maintainability impact that results from the door redesign. Phase I of the effort, which affects the two forward inboard doors, anticipates an Operation and Support savings of \$532K over 25 years and the recovery of about 60 mission readiness days per year. Phase II, which affects all eight doors, expects an Operation and Support savings of \$5.9M over 25 years and the recovery of an additional 30 mission readiness days per year.



***Damaged Main Landing Gear Door***



***Improved Landing Gear Door Design***

### **Affordable THAAD Missile Canisters for Improved Missile Platform Protection**

Previously fielded conventional composite THAAD missile canisters and flight tested systems did not have requirements for armoring of their missile canisters, making them vulnerable to sniper fire. New lightweight, integrated armor and composite structures were developed and manufactured to provide ballistic impact protection and to eliminate possible damage or detonation to the missile during combat conditions. The improved composite material, that is lighter and more affordable, provides security and confidence to the platform crew under live fire. Weight reductions associated with the integral ceramic armor and bonded aluminum flanges result in a lower total ownership system costs. Overall the structures are less costly due to a 30% reduction in touch labor. MDA funded this project at \$800K to achieve 2X the cost savings using the improved composite missile canisters.

## **4. FY06 Sustainment and Readiness Highlights**

### **Engine Rotor Life Extension (ERLE) Program**

The ERLE program helped reduce the Air Force's sustainment burden for gas turbine engines. Cost savings to the Air Force in the first year of implementation exceeded \$6.3M resulting from not having to purchase new engine parts and from reduced inspection cycle-times. The cost benefit is projected to exceed \$350M over the life of the weapon systems. At the Oklahoma City Air Logistics Center (OC-ALC), ERLE implemented advanced non-destructive inspection technologies for application to current and future generation engines. These technologies – now used every day on the inspection shop floor at OC-ALC – permit safe life extension of engine components for a third inspection interval (roughly seven to ten years of additional service). Based on achieved successes, OC-ALC has committed funding to implement this advanced

technology on the remaining inspection systems at the depot. The ERLE program's impacts the life-cycle cost of the F-15, F-16, B-1, and B-2 engine fleets and will free significant resources for other Warfighter priorities. This project was recognized and honored for its outstanding FY06 technical accomplishments as one of the recipients of the 2006 DMC in Nashville, TN.

### **National Forging Tooling Database to Reduce Cost of Replacement Parts**

Warfighters use systems that have been around for years and sometimes decades. Replacement parts for these systems were usually out of production and had to be made to order. The dies for forged parts were scattered among many small foundries and were difficult to locate. Redesigning and remanufacturing the tooling for these parts is time consuming and costly. To speed resupply of forged replacement parts, the DLA ManTech program invested in the National Forging Tooling Database. It identifies the location of forging dies across the United States. Currently, the database holds locations for over 200,000 forging dies, with an estimated value of \$4.1B. The database accurately locates 85 percent of the tooling needed to produce forged parts with national stock numbers. Locating dies for just eight forged parts results in a cost avoidance of \$109.8K and an estimated 3-4 months time savings in the acquisition of each part.

#### ***Database Saves Time and Cost for Replacement Parts***



## **5. FY06 Extended Production Enterprises Using Information Technology**

### **Model Centric Systems for Design and Manufacturing**

The Army assembled a government-industry-academia team – Army Research Lab, NIST, BAE, GDLS, Boeing, Parametrics, and Penn State University – to assure modeling/simulation flow down requirements were quickly implemented to reduce costs. Cooperative agreements with Boeing, and BAE were awarded and efforts proceeded in developing model based definitions and a model centric manufacturing enterprise. The goal was to simulate a planned manufacturing environment before executing any physical manufacturing to ensure that the required operations can be performed in an efficient and effective manner and to reduce manufacturing cost.

The team successfully created a modeling and simulation environment where CAD information from Pro-E – being used by the Future Combat System Vehicle Integrators – can move in and out of the Production Processes Resource Hub and interact with Delmia CAM tools. Changes can then flow back through the PPR hub in order to modify design. Efforts focused on: moving manufacturing and design data such as notes, symbols, dimensions/tolerances, surface finish specs, datums, etc. easily through the hub with minimal manual oversight/entry; and establishing layered views in 3-D images to present necessary descriptive data in an easily understood view rather than have it all contained on a single view that makes it unintelligible. The end product enables team members to exchange design and manufacturing information seamlessly in an open collaborative environment.

The Army ManTech Program sponsored work to develop a modeling centric system to simulate planned manufacturing environments in order to reduce the number of engineering changes, cost of changes made, and the time required to make changes. This process created a paperless or near paperless environment on the shop floor at Red River Army Depot in AL. To date over 2300 vehicle transmission parts at the Depot have been processed through the model based manufacturing tools.

### **Product Centric Facility Design**

Structural fabrication constitutes approximately 20-30% of the recurring labor hours for each Virginia Class Submarine delivered to the Navy. The objectives of this Navy ManTech project included development of a conceptual design and layout incorporating manufacturing concepts based on similar product families; re-engineering the existing manufacturing processes to reduce costs and span-time; and integrating new production technologies and manufacturing strategies into the existing facility. The results were implemented at General Dynamics Electric Boat with funding from Navy PMS450. EB is implementing manufacturing cells for two of the major part families (structural shapes and digital data shielding) and one of the major product lines (decks). It is expected that up to 30% of part manufacturing cost will be eliminated. The deck manufacturing cell will save over 25% of the manufacturing costs and is expected to cut the span-time by 40%.

### **Continuous Process Improvement Tools for Patriot Advanced Capability (PAC-3)**

Three manufacturing continuous process improvement tools – Lean (for waste reduction), Six Sigma (for variation elimination) and *Lean-Pathways* (LPW) – were transitioned to MDA programs. LPW events, interactions, engagements, and projects were completed with four MDA prime defense contractors and their 47 Defense Suppliers in order to identify MDA opportunities for Continuous Improvement engagements. The PAC-3 missile system was chosen as the first full MDA engagement in which four suppliers used Lean, Six Sigma (6S) and LPW to achieve the following results in FY06:

- a. Raloid – machine shop in Reisterstown, MD that manufactures major components for PAC-3
  - Implemented a formal 6S program in 60% of their manufacturing area;
  - Setup reduction in their CNC Milling Area resulted in 70% reduction in people travel from 18,000 to 5400 feet and a potential 53% reduction in setup time from 28 hours to 13 hours on their MDA Avionics Housing and Cover Plate Assembly parts
- b. BJG – manufactures parts of the PAC-3 guidance system in Ronkonkoma, NY
  - Implemented a formal 6S program in the warehouse and quality assurance Department.
  - Improved the Return Merchandise Authorization Process – the results were a 50% reduction in process steps from 46 to 23 and a 48% reduction in process lead time from 23 to 12 days.
- c. LGS – manufactures gaskets and cover plates for PAC-3 in Lexington, TX
  - Implemented a formal 6 Sigma program in Steel Stamping Process.
  - Setup reduction in their Pederson Stamping Machine resulted in a potential 80% reduction in setup time from 25 to 5 minutes on this general purpose and biggest income-making machine.

- d. Seytec – distributor for aviation fasteners in Hurst, TX
- In-process of implementing a formal 6S program in their Shipping/Receiving Area
  - Developed a conceptual floor plan for new facility (Lean Green Field Facility) where it is expected to reduce people and part travel by 50%, reduce order to ship cycle-time by 25%, and reduce number of shippable backlog by 50%.

## ACRONYM LIST

| ACRONYM | DEFINITION   |
|---------|--|
| 6S      | Six Sigma  |
| AEA     | American Electronics Association   |
| AFCEA   | Armed Forces Communications and Electronics Association                  |
| AFRL    | Air Force Research Laboratory  |
| AIA     | Aerospace Industries Association   |
| AMC     | American Metalcasting Consortium   |
| AMMT    | Advanced Materials Manufacturing and Testing                             |
| AMMTIAC | Advanced Materials Manufacturing and Testing Information Analysis Center |
| AMRDEC  | U.S. Army Aviation Missile Research Development and Engineering Center   |
| AMT     | Association for Manufacturing Technology                                 |
| ARDEC   | U.S. Army Armament Research Development and Engineering Center           |
| ASA/ALT | Assistant Secretary of the Army (Acquisition, Logistics, and Technology) |
| ATD     | Advanced Technology Development  |
| ATO     | Army Technology Objective  |
| ATO-M   | Army Technology Objective (for Manufacturing)                            |
| BATTMAN | Battery Manufacturing  |
| BMPCOE  | Best Manufacturing Practices Center-of-Excellence                        |
| CMTC    | Composites Manufacturing Technology Center of Excellence                 |
| CNST    | Center for Naval Shipbuilding Technology                                 |
| COE     | Center-of-Excellence   |
| CORANET | Combat Rations Network   |
| DAC     | Defense Acquisition Challenge  |
| DAU     | Defense Acquisition University   |
| DDR&E   | Director Defense Research and Engineering                                |

|        |  |
|--------|--|
| DHS    | Department of Homeland Security                                |
| DLA    | Defense Logistics Agency                                       |
| DMC    | Defense Manufacturing Conference                               |
| DoC    | Department of Commerce   |
| DOD    | Department of Defense  |
| DoE    | Department of Energy   |
| EMPF   | Electronics Manufacturing Productivity Center                  |
| EMTC   | Energetics Manufacturing Technology Center                     |
| EOC    | Electro-Optics Manufacturing Technology Center                 |
| ERLE   | Engine Rotor Life Extension Project                            |
| EWI    | Edison Welding Institute                                       |
| FCS    | Future Combat System   |
| FCT    | Foreign Comparative Testing                                    |
| FDC    | Flexible Display Center  |
| FPA    | Focal Plane Array  |
| GEIA   | Government Electronics and Information Association             |
| HHP    | Horizontal Hinge Pin   |
| IBA    | Industrial Base Assessment                                     |
| iMAST  | Institute for Manufacturing and Sustainment Technologies       |
| InSb   | Indium Antimonide  |
| ISF    | Isotropic Superfinish  |
| JDMTP  | Joint Defense Manufacturing Technology Panel                   |
| JUMPED | Joint Ultimate Manufacturing Process Evolution and Development |
| JWSTP  | Joint Warfighting Science and Technology Plan                  |
| LBI    | Lean Battery Initiative  |
| LPW    | <i>Lean</i> Pathways   |
| LRAS3  | Long Range Advanced Scout Surveillance Suite                   |

|                    |  |
|--------------------|--|
| ManTech            | Manufacturing Technology   |
| MDA                | Missile Defense Agency   |
| MDA DEP            | Missile Defense Agency Directorate for Producibility and Manufacturing   |
| MDA MP Program     | Missile Defense Agency Manufacturing and Producibility Program   |
| MEMS               | Micro Electro Mechanical System  |
| MEP                | Manufacturing Extension Partnership  |
| MMIC               | Monolithic Microwave Integrated Circuit  |
| MRA                | Manufacturing Readiness Assessment   |
| MRL                | Manufacturing Readiness Level  |
| NACFAM             | National Council For Advanced Manufacturing  |
| NAM                | National Association of Manufacturers  |
| NCAT               | National Center for Advanced Technologies  |
| NCDMM              | National Center for Defense Manufacturing and Machining  |
| NCMS               | National Center for Manufacturing Sciences   |
| NDIA               | National Defense Industrial Association  |
| NGMTI              | Next Generation Manufacturing Technology Initiative  |
| NIST               | National Institute of Science and Technology   |
| NJC                | Navy Joining Center  |
| NMC                | Navy Metalworking Center   |
| NSF                | National Science Foundation  |
| NTTC               | National Technology Transfer Center  |
| ODUSD (AS&C) / OTT | Office of the Deputy Under Secretary of Defense (Advanced Systems and Concepts, Office of Technology Transition) |
| PEO                | Program Executive Office   |
| PIF                | Prototype Integration Facility   |
| PM                 | Program Manager  |
| PRO-ACT            | Procurement Readiness Optimization Advanced Casting Technology   |

|            |  |
|------------|--|
| PRO-FAST   | Procurement Readiness Optimization Forging Advanced Systems Technology |
| QDR        | Quadrennial Defense Review   |
| R&D        | Research and Development   |
| RDEC       | Research Development and Engineering Center                            |
| RDECOM     | Research Development and Engineering Command                           |
| RDT&E      | Research Development Test and Evaluation                               |
| RF         | Radio Frequency  |
| S&T        | Science and Technology   |
| SBIR       | Small Business Innovation Research                                     |
| SME        | Society of Manufacturing Engineers                                     |
| STTR       | Small Business Technology Transfer                                     |
| TEO        | Technology Executive Office  |
| TIC        | Technical Information Center   |
| TRADOC     | U.S. Army Training and Doctrine Command                                |
| TRL        | Technology Readiness Level   |
| TTA        | Technology Transition Agreement  |
| TTP        | Technology Transition Plan   |
| TWG        | Technical Working Group  |
| TWT        | Traveling Wave Tube  |
| U.S.C.     | United States Code   |
| USD (AT&L) | Under Secretary of Defense (Acquisition Technology and Logistics)      |
| WIN-T      | Warfighter Information Network - Tactical                              |